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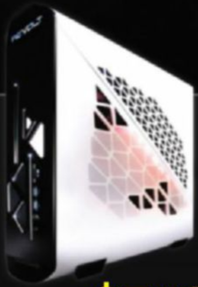

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Tuan
Nguyen

UPGRADES AND FIXES FOR THE ELITE

THERE WAS A TIME when RAM was expensive. I remember going out to buy 32MB—yes, megabytes—of EDO DRAM for almost $400. They don't even make USB thumb drives that small any more. I think my analog wristwatch has more memory than that.

RAM upgrades are the easiest improvements you can make to a PC to eke out some extra performance, especially if you tend to run a lot of programs simultaneously. If you're primarily gaming and nothing else, 16GB is likely enough, but I think the sweet spot is going to be 32GB sooner than we expect. For me, I have web browsers open with a gazillion tabs, email, IM programs for work and personal use, music, and a VNC remote desktop client. I still don't come close to utilizing 32GB of RAM but since I actually have 64GB, I never have to think about it. Moral of the story? Get enough RAM so that you don't ever have to worry about needing more.

The first thing you should absolutely do after a RAM upgrade is make sure to enable XMP mode in your BIOS, to get full performance out of your system. Without XMP enabled, your RAM will run at the default clocks associated with your CPU and platform. You'll want to test and see what works best. You're probably wondering what I'm using. Corsair Dominator Platinum 2800s—four DIMMs, 16GB each. Ooh, yeah.

After upgrading your rig with copious amounts of RAM, you're bound to want to make sure the rest of your system is in tip-top shape.

Fortunately, there are plenty of options if you're running Windows 10. When it was released, Microsoft said that Windows 10 would be the best Windows to date. For the most part, this is true. But there are areas of concern.

First and foremost, if you're a privacy nut, you'll want to go into Windows 10's cloud settings and disable a heap of options that constantly keep your PC dialing back to the mother ship. What you search for, how you use your programs, error logs, and so on, are all logged and sent to Microsoft to give you a "better" experience.

On the flip side, all these things actually do assist Microsoft in improving Windows 10. These features are also core to Windows 10's responsiveness when you're searching for information. Lots of people want their PCs to be connected to cloud services that make the most use of their Internet connection, so that things can be accessed quickly, but for privacy's sake, it's always a give and take. Aside from these, there are lots of other areas in Windows 10 that will yield performance improvements if addressed. We show you how.

Circling back, does anyone remember what EDO DRAM is? If you do, congratulations on being old. If you don't, you need a bit of schooling. Take our geek quiz and be admitted with honors into our elite society.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 19 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Zero-Rated Services Test Net Neutrality

Legitimate use? Or are they exploiting a legal loophole?

The FCC is taking a wait-and-see approach to zero-rated services such as T-Mobile's Binge On program.

AS ANY PARENT knows, children make it their mission to test the rules to see exactly how much (or little) they can get away with, as the line drawn in the sand can sometimes be moved just a smidge. The Federal Communication Commission finds itself in a similar position after laying down the net neutrality law with its Open Internet Order, a set of rules designed to ensure that all data on the Internet is treated equally. As expected, service providers have begun testing the limits of the FCC's rules.

T-Mobile is leading the charge with its Binge On program. Binge On is one of a growing number of so-called "zero-rated" services, which are services that don't count against a user's data cap. Through Binge On, T-Mobile allows customers on qualifying plans to stream unlimited video from a list of two dozen partners, including Netflix, Hulu, and HBO Go. T-Mobile throttles the streaming video to 480p, and in exchange for the lower quality video feeds, customers on qualifying plans can binge until their eyeballs bulge out, and none of it will count against their data caps.

But wait, isn't throttling prohibited by the FCC? This is where things get tricky. In an email to DSL Reports, a T-Mobile representative argued it's "misleading" to use the term "throttling," and that a better descriptor is "mobile optimized." The explanation boils down to semantics, though more importantly, T-Mobile isn't selling faster access to services; there are no paid fast lanes. Instead, any streaming service that meets a set of technical requirements can participate in Binge On.

These types of services have drawn the attention of the FCC, which at the moment is taking a wait-and-see approach to the situation. FCC chairman Tom Wheeler even went so far as to praise Binge On when asked about it during an open meeting.

"I think that it's clear in the Open Internet Order that we said we are pro-competition and pro-innovation. Clearly, this meets both of those criteria; it's highly innovative and highly competitive," Wheeler said.

As far as Wheeler is concerned, programs like Binge On are proof that fears of the FCC thwarting innovation with its reclassification of broadband as a utility are unfounded. At the same time, Wheeler said the FCC is "keeping an eye on" Binge On and other similar services, which will be judged on a case-by-case basis.

The FCC has sent letters to T-Mobile, AT&T, and Comcast, asking for details of their free data programs. Wheeler insists the intent of the letters is merely to stay informed, though depending on how things go, the FCC could decide to launch an investigation at any time.

One of the arguments against zero-rated services is that it forces smaller companies to follow suit and spend more than they can afford on advertising their offering. An arguably bigger fear is that zero-rated services give providers power to pick winners and losers in the online content wars.

It all boils down to a giant gray area—one which the FCC is content to let play out so long as service providers don't take things too far. **–PL**

> “Isn't throttling prohibited by the FCC? This is where things get tricky.

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OVER THE HOLIDAYS, children's electronic and educational toy manufacturer VTech Holdings Limited confirmed that hackers accessed its Learning Lodge app store database on November 14, exposing the details of over 11 million parents and children. Learning Lodge allows customers to download apps, games, e-books, and other educational products to VTech devices.

"Our customer database contains general user profile information including name, email address, encrypted password, secret question and answer for password retrieval, IP address, mailing address, and download history," the company stated.

VTech stressed that the database does not contain credit card information, nor does the Learning Lodge website. This data is provided on a secure, third-party payment gateway during the check-out process. VTech also does not store social security numbers, driver license numbers, or any other ID card number.

The breach was first noted by a Canadian journalist who asked about the incident on November 23. The company conducted an internal investigation and discovered "irregular activity" taking place on the Learning Lodge website on November 14, but didn't alert the public until November 27.

Recent reports have revealed that the hacker not only gained access to email addresses and physical addresses, but images of parents and children taken with VTech products, chat logs, and audio files. The company has acknowledged these reports but said that while the investigation is ongoing, it cannot confirm them.

The company says that audio files are encrypted by AES128 whereas chat logs are not encrypted. Chat logs are also only stored temporarily on the server if they are marked undelivered, and they expire in 30 days.

Profiles of children that were exposed include name, gender, and birth date. **–KP**

USPS WILL EMAIL IMAGES OF YOUR SNAIL MAIL

IF YOU CAN'T BEAT 'EM…

REMEMBER THAT BOX that sits out in front of your house? The one that doesn't have a separate spam box and likes to stockpile more junk than legitimate letters? It's become less important now that email has taken over.

The United States Postal Service is seemingly acknowledging that fact by offering a new service called Informed Delivery. Essentially, customers will no longer have to make daily trips to the mailbox. Taking advantage of how we keep our eyes glued to smartphones, tablets, and notebooks, all customers have to do is open their inbox to see what's waiting outside in the mailbox.

USPS says participants in the program will receive 10 mail piece images in the morning. If the customer has more mail waiting in their box, the additional images can be viewed online via their My USPS account. **–KP**

HTC DELAYS VIVE VR HEADSET

Blame it on a breakthrough

HTC CEO CHER WANG, speaking in December at the Vive Unbound developers forum in Beijing, said that HTC and Valve Software had made "a very, very big technological breakthrough."

According to Wang, this breakthrough is significant enough that HTC and Valve Software have decided to set aside the Vive VR headset that they had originally planned to release in Q4 2015, and hold off until an improved model is ready, which is currently slated for April 2016. "We shouldn't make our users swap their systems later just so we could meet the December shipping date," Wang said.

The CEO wouldn't go into any sort of detail regarding the breakthrough itself, but promised more news would be released about the improved Vive headset during CES 2016. **–KP**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

DADDY BIG BUCKS

In a letter to his newborn daughter, Mark Zuckerberg pledged to donate 99 percent of his Facebook shares to charitable causes during his lifetime.

OPENING LOCKED DOORS

Due to an architecture change, mobo makers released BIOS updates for Z170 mobos enabling users to overclock non-K Skylake CPUs.

BETTER BROADBAND

The latest version of an ongoing FCC study reveals US average broadband speeds tripled in three years.

TRAGEDIES

PLAYING THE BLAME GAME

A Russian gamer who neglected his wife, job, and friends in favor of *Fallout 4* ended up suing Bethesda for making an addictive game.

WHERE'S DOOR NUMBER 3?

Microsoft splashed PCs with pop-ups imploring users to upgrade to Win 10 with two options: "Upgrade now" or "Upgrade tonight."

SORRY, NOT SORRY

Microsoft apologized for tightening OneDrive storage caps but held firm on decision to remove unlimited tier.

Dave James

TECH TALK

MQA's Audio Origami Will Fold Up High-Res Audio

SOMETHING HAPPENED when we went fully digital with our music. Something massively convenient but pretty awful on the ears. MP3s are certainly easy to carry around and delightfully lightweight to stream, but quality audio they ain't. MQA, however, is bringing the holy grail of studio master quality to streaming.

We went from a steady raising of the audio quality bar to a massive drop when we shifted from using physical media to just storing the ones and zeroes on a hard drive. Compressing audio to the 256kb/s level of iTunes' AAC files, and the 320kb/s MP3 level of Spotify, means cutting out a huge amount—up to 90 percent—of the original sound. That does bad things for a track's clarity but makes it convenient when it comes to accessing a huge library of tracks on something you can fit in your pocket.

Things are slowly changing, with the likes of Tidal offering CD-quality streams—16-bit, 44.1kHz FLAC files streaming at 1,411kb/s—thanks to the increased bandwidth available in the home and when mobile.

But that's just taking us back to the quality we had with CDs. How do we push further without resorting to high-res FLAC albums that take up 1.5GB?

Master Quality Authenticated (MQA) may be a mouthful, but it's the future of high-res audio (HRA). The first thing to get to grips with, though, is what we mean by "resolution" when talking about sound.

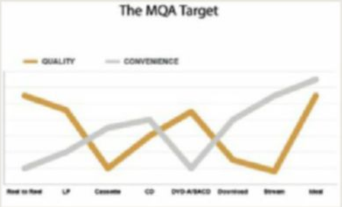
When we're referring to what we can see, it's easy. Resolution is the number of distinct pixels on a screen. Simple. But it's that "distinct" bit that's important—in audio terms, resolution is all about being able to resolve different sounds in a file. When a track is compressed, it becomes "lossy." It loses some of the distinct sounds, as they have to be crushed together to be able to form a smaller file size.

> “
> Audio Origami folds up files to a manageable size, and allows them to be unpacked with all the audio data intact.

A 192kHz, 24-bit lossless file sounds stunning, but is huge and impractical for streaming purposes. That's where MQA comes in. Its Audio Origami folds up audio files to a manageable size, retaining all the information, and allows them to be unpacked at the other end with all the audio data intact.

That's where the name comes from—it takes studio master quality audio in at the start of the pipeline and you can be sure that it will sound exactly the same at the other end. Which is awesome for audiophiles, but is just as good for everyone else, because even without a hardware or software MQA decoder at the final stage, the file unpacks to whatever size the player can cope with. It will always be better than CD quality, and therefore high-res audio.

That's huge news for streaming companies, and Tidal has committed to having MQA streams in 2016. It works for Tidal because it needs to store a huge number of files for each track in its library because of the different bitrates it streams at.



The aim of MQA is the convergence of convenience and quality.

Tidal currently has 1.4 petabytes of audio, much of it duplicated because of all those different formats.

With MQA able to dynamically unfold to whichever size is needed, it won't demand so much storage, saving Tidal a huge amount of cash as well as meaning it can offer HRA streaming for the first time. And all with files not much bigger than its current top-tier audio stream.

The first MQA devices, such as Pioneer's new XDP-100R portable HRA player, are now arriving, and with Tidal kickstarting the high-res streaming revolution this year, 2016 could well be when high-resolution audio just becomes audio. Trust me, hearing is believing.

Dave James has been building and writing about PCs and their components for the last two decades.

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Alex Campbell

OPEN SOURCE

SteamOS's Low Boiler Pressure

WHEN I FIRST HEARD ABOUT the idea of Linux-based Steam Machines, I was excited. I thought to myself: "Hey, game developers finally care about Linux. This will be great for Linux, for gamers, and for the open-source community." I still want that to be true.

The thing is, SteamOS, and Steam Machines in particular, have their problems. Valve set out with a grand ambition for Steam Machines, and it had the user base to back it up. Imagine building a PC just for gaming, having access to your Steam library, without having to pay the Windows tax. Great idea, except for one fatal flaw.

The number of titles available to Linux and SteamOS users is still small compared to the Windows library. At time of writing, there are 3,389 games available to SteamOS and Linux. But when you consider that 15,288 games are available to Windows users, things begin to look a little bleak. That's only 22.1 percent of Steam games that are available to Linux. Hell, Mac OS X even enjoys a bigger library at 5,602 titles (or 36.6 percent).

That poses a big problem for makers of Steam Machines. How are you supposed to market a box that can only play a fraction of the Steam library? I mean, I like the form factors that Alienware and Syber have been putting out there, but selling them as SteamOS (as opposed to Windows/Steam big-picture mode) boxes might be tough, given the small numbers of games currently available on Linux.

That said, there has been a steep increase in the number of Steam games available to Linux. Steam hit the 1,500-game mark for Linux just last September. That number more than doubled in about three months. Given that growth, it's possible that gamers on SteamOS could see a rapid inflation in game offerings. The other thing SteamOS has to do is get killer apps such as Netflix, Twitch, and Hulu on board. Without content providers, it's hard to compete with the PS4, Xbox 360, or even the Wii. (My PS3's primary role is that of Netflix machine.)

> There are 3,389 games available to SteamOS and Linux, but 15,288 available to Windows users—things look bleak.

SteamOS games haven't built up the pressure to get the platform moving.

In a perfect world, the Debian-based SteamOS should be at or near parity with Windows offerings. That's not likely to happen, because of DirectX. Asking game devs to port to OpenGL for the sake of Linux users is a really tall order.

There is one way gamers have been able to get DirectX games to run in Linux, and it's called WINE. WINE isn't perfect. It isn't sexy (though the PlayOnLinux wrapper makes it a bit sexier). Compatibility can be really hit-or-miss. But when things work, WINE is a godsend.

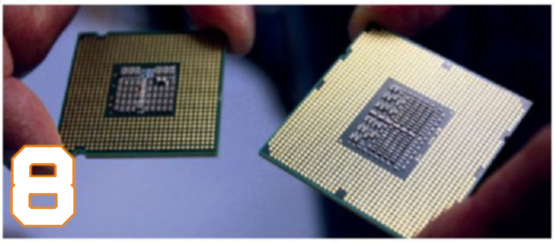
Experimental DirectX 11 support appeared in WINE in the summer of 2015 (in version 1.7.50). Sure, native support for Linux will always yield the best compatibility and stability, but WINE may offer Steam machines a way around DirectX exclusion. If Valve hired a few developers who would dedicate their existence to getting DirectX 11 (and 12) support to be the best it can be in WINE, a world of Windows games could be opened to Linux and SteamOS.

Using things such as PlayOnLinux as a guide, Steam could create a WINE wrapper for its Windows offerings. Sure, WINE isn't the best way to do things, but it's better than being cut out of the AAA ecosystem entirely. The pay-off could be really big for both Valve and Linux gamers if the resources go into it.

Alex Campbell is a Linux geek who enjoys learning about computer security.

THE LIST

8 PRODUCTIVITY TIPS AND TOOLS



8

UPGRADE YOUR PC If you use your PC for work, it will save you time and money in the end if you've got enough RAM, CPU, or GPU power to speed up processes.

Get Installer

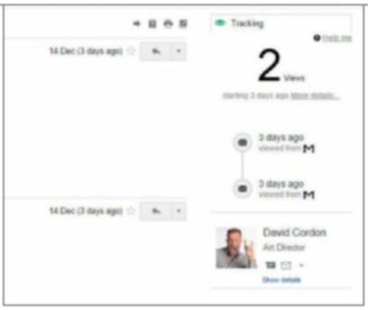
7

NINITE.COM This website is a godsend if you set up PCs as much as we do. It offers a one-time package download for all your favorite and free programs.

DriverUpdate

6

SLIMWARE UTILITIES DRIVERUPDATE This program saves you time by downloading every single update and driver your PC needs.


14 Dec (3 days ago)
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14 Dec (3 days ago)
David Cordon
Art Director

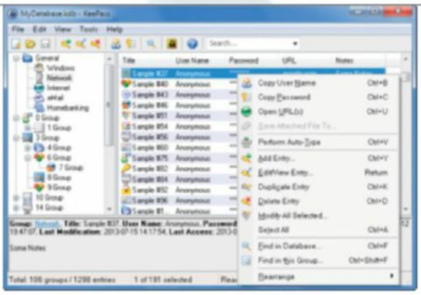
5

STREAK EXTENSION If you use Gmail, this enables you to see whether your emails are being read.

Foolproof Whole Wheat Apple Muffins

4

POCKET Come across an interesting article or video, but don't have time to read it? Save it to your virtual pocket folder to read it later.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Help
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Copy Password
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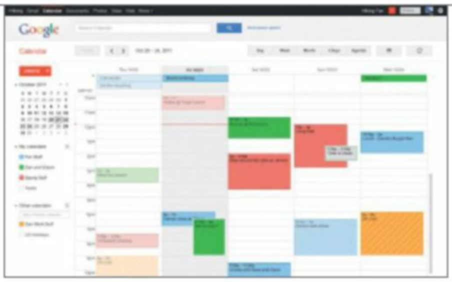
Perform Auto-Type
Add Entry...
Edit/View Entry...
Duplicate Entry
Delete Entry
Select All
Find in Database...
Find in this Group...
Rearrange

3

KEEPASS With this free software, you'll never have to remember more than one password again.


Google
Calendar

2

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1

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TALKING

BY **JIMMY THANG**

Palmer Luckey Discusses the Future of VR

We ask the man behind the Oculus Rift whether the monitor screen as we know it is doomed

Unless you live under a rock, you'll have noticed the rise of the gamer's gem of technological advancement, the Oculus Rift—and, more importantly, the rebirth of virtual reality. Couple that with Microsoft's advances in augmented reality, and the next decade may see monitors begin to change irrevocably. We sat down for a chat with Oculus VR's founder about his thoughts on the future of Oculus Rift, VR, and virtual media as a whole.

Could VR change the media landscape for ever? Palmer reveals all in this exclusive interview.

Maximum PC: We're here with Oculus VR's founder, Palmer Luckey. Palmer, we have some questions for you, if you don't mind.

Palmer Luckey: Fire away!

MPC: For those who haven't been following the VR scene, what is the status of VR right now, and what do you expect to happen in the next year?

PL: Right now, the status of virtual reality is that we've seen several years of kind of a consumer-free market—we've seen a lot of developers, we've seen a lot of enthusiasts getting interested, and we've seen a lot of content in development, but we haven't really seen any major consumer launches in the virtual reality space. And with people like Oculus, and Sony, and HTC all entering the space at around the same time, over the next year we're going to see a huge explosion in the number of people who have had exposure to VR, and a huge explosion in the number of virtual reality games that are being published publicly.

MPC: This isn't the first time that VR has made an attempt to go mainstream, so what's different this time around?

PL: There's kinda two sides. One is the side we control. It's things like displays, optics, and motion sensors. Those weren't nearly as good in the past—it's really only in the last few years that it's become viable to build a good virtual reality headset. But more than that, it's the proliferation of high-end computers for everybody. If you look back to the '80s and '90s, when virtual reality was kinda having its first serious run at mainstream penetration, the best VR experiences were running on, like, SGI workstations that cost tens of thousands of dollars, or even hundreds of thousands of dollars. But now everyone's computer is capable of rendering high frame rate 3D graphics—maybe not photo-realistic ones, maybe not to the level of quality that we want from virtual reality in the near and distant future, but it's enough to make it work. And so, for the first time ever, virtual reality is actually viable as something you can use at home. If you look back to the '80s and '90s again, those companies didn't fail because of bad business or bad marketing, or because consumers thought it was weird—it's because people

Ahh, the beauty that is VR in its glorious original form.

didn't have machines that could render an experience that was anything close to comfortable or compelling, and that's all changed.

MPC: So you think it's more of a timing issue, then?

PL: It's almost entirely a timing issue. It would have been impossible to start Oculus in even the mid-2000s. It wasn't until between 2007 and 2009 that the technology was becoming viable enough to build something on the level of the development kits that we've shipped so far.

MPC: Do you envision VR going mainstream? And what about flatscreen displays? Will they disappear, too?

PL: Eventually, but it's all a matter of time. Traditional displays going away isn't so much a VR problem as an AR problem, because people are always going to want to place displays into the real world, or at least into something approximating the real world. But you're going to see the convergence of AR and VR technologies into the same sets of headsets eventually. It'll be something you wear all the time, or at least that you carry around all of the time. And the render horsepower is going to be on the headset, or in your pocket, not tied to a big desktop PC. As far as going mainstream? Again, it's just a matter of time, a matter of having a good enough experience, with enough content, at a low enough cost. Right now, the math is a little wonky—it's pretty expensive to get into virtual reality, and there's not a lot of content relative to other forms of media, like film, music, books, even traditional games. And the quality of the experience, while acceptable, isn't something that's going to make everybody truly feel like they've been teleported into a new place. We can reliably induce a sense of presence, a sense of making someone feel like they're in a virtual environment to their lizard brain. But tricking the conscious mind into ignoring the flaws is difficult. As the quality goes up, and as the amount of content goes up, and the breadth of content goes up, so that you know there's something for everybody, that there's television shows for all different audiences today, not just narrow slices of people, you're going to see more and more people get interested in virtual reality, because the quality is going to be very high, and there's going to be things they're interested in playing. And then the only factor left is cost. Right now, if you need to have a fairly high-end PC, and then buy a VR headset, you're kind of limited to a smaller audience. If you look into the distant future, where everything is going to be rendered on the headset, and we'll be able to get mobile systems on a chip to render really incredible graphics, now you have something that is like mobile phones. It started out at many hundreds of dollars, and it dropped to sub-$100 unsubsidized. Something that many people around the world can afford to use, and that's when virtual reality will become truly mainstream.

MPC: Do you think this is something that's just going to be a really cool niche product?

PL: Virtual reality will be a niche product for at least some time. If you look at the Palm Pilot, it's a good example. The Palm Pilot was very well known, it was very influential, but it wasn't something that everybody wanted to use and that everyone could justify. They sold millions of units, and a lot of people recognize the Palm Pilot, and they built a great brand, but you could say that the Palm Pilot was a niche product. It was techies, business people, people who wanted this portable computer that could keep track of their calendar, their applications, their emails on the go, but eventually the technology got good enough, and the cost came down enough, that we had things like the iPhone that really took off, and everyone could justify having this type of technology in their lives. I think virtual reality is going to be on the same continuum. It can be successful as a niche product, it doesn't have to be mainstream and appeal to everyone in the entire world in order to be successful, but that is the eventual end goal. It's to build something that everybody will have a use for, and I think that virtual reality will inevitably have a use for everyone, because anything you can imagine doing in real life, you can do eventually as well or better in virtual reality. Without physical laws governing what you can do, without monetary and fiscal laws dictating what you can do. Experiences that are limited to a very elite few right now could become available to everybody, and whether it's just for entertainment, like traveling to Hawaii, or education, being able to travel to different places, experience different things, potentially even experience things as they used to be in the past, we can't do that with any other technology. And if we look at human history, whether it's epics of old, music, or movies, even modern video games, it's all a reflection of people's desires to see and do incredible things, things that are outside of their ordinary existence. Virtual reality is the ultimate conclusion of that in my opinion—it's likely to be the final form of media. It's hard to come up with a form of media that goes beyond something that can not only be its own set of media, but also replicate every other form of media that's ever existed.

Hungry for more? You can watch the full interview with Palmer Luckey online here: http://bit.ly/MPCVRInt

DOCTOR

THIS MONTH THE DOCTOR TACKLES…

> Folding@home GPU
> The M.2 Truth
> Bandwidth Issues

Folding @ Top Speed

Hey Doc. I have a PC that I threw together with some spare parts I had lying around. It's not much, but I only use it as a dedicated Folding@home and distributed compile machine. The system sports an Intel Pentium G3258 in a Mini-ITX form factor, with 4GB of RAM, and a 450W PSU. For now, I'm only using Intel integrated graphics, but I'm thinking about adding a discrete GPU to accelerate folding performance. What should I use, though?

I've heard that, for a lot of non-gaming GPU-accelerated compute tasks, AMD's architecture performs better. However, I'm personally partial to Nvidia. So, which is better for folding performance: an AMD Radeon R7/R9-based board or a GeForce GTX? And if I do go with Nvidia, would I see much advantage from a low-level Quadro card over the desktop-oriented GeForce? Thanks!

–Dan Egli

THE DOCTOR RESPONDS: Are you looking for the best performance, price be damned? The best PPD (points per day) per unit of power consumption? Or the best PPD per dollar? According to the official Folding@home forum, Nvidia's GeForce GTX Titan X is commonly considered your fastest option. Meanwhile, the GeForce GTX 970 gets props time and time again for its PPD/watt ratio.

HYPERX
PREDATOR
Kingston
Warranty Void If Removed

Kingston's HyperX Predator is one of many M.2-attached SSDs able to drop on to the PCIe bus, giving performance far in excess of SATA.

Don't worry about spending extra money on a workstation-class graphics card, either. The Folding client doesn't benefit from the optimized drivers you get with a Quadro board. Those are typically tuned for professional CAD and engineering applications. Similarly, it gets nothing from the double-precision floating-point math or ECC algorithms enabled on compute-oriented cards, such as Nvidia's Tesla and AMD's FirePro.

Battling Bad Behavior

Hi Doctor, I recently updated my Windows 8.1 system to Windows 10. It ran for a couple of weeks, but then started to exhibit display corruption, slow browser refreshes, desktop color craziness (all text and backgrounds turn clear so you cannot read any of the menus), and eventually I have to reboot. It's good for another few minutes after that. Most of my issues manifest while I'm browsing the web, but can crop up at any time.

The system board is an Asus P7P55D-E with a Core i7-860, and 12GB of RAM; I have a Radeon HD 5700-series video card plugged in, too. AMD does not have any drivers newer than the ones I'm running (15.201.1151.0).

Do you think that, due to the relative age of the video card (it's around three years old now), it's time to buy a newer one that might coexist better with Windows 10? I didn't have any issues with Windows 7 or Windows 8.1, and never overclocked. If you recommend a new board, what would be a reasonable choice? I don't do much gaming, but do appreciate a peppy system.

I have tried uninstalling the current video drivers, rebooting, and letting Windows discover the card on its own. That works for a little while, after which I'm battling the same issues. Do you have any advice for a long-time *Maximum PC* reader?

–David Knapp

THE DOCTOR RESPONDS: The troubleshooting process is fraught with frustration and hard-fought victories. In this case, the fact that you can recover stability and then quickly lose it once again suggests you could have a component that might be cooling down and then overheating. Have you popped the side off your chassis to check that all is well with the Radeon's cooling fan? How about using GPU-Z to monitor the temperature of AMD's Juniper processor?

If everything checks out on the hardware side, try starting over with a fresh driver install. Use DDU (www.wagnardmobile.com/DDU/) to clean out any remnants of older Catalyst versions, and then grab the 15.11.1 Beta (http://amd.com/beta), which is a little newer than what you were using before.

At the end of the day, though, that graphics card is getting old, and AMD won't

↘ submit your questions to: doctor@maximumpc.com be supporting it with driver updates moving forward (the latest Radeon Software Crimson Edition build only goes as far back as Radeon HD 7700+ support)—so you might want to start thinking about an upgrade.

Set the Record Straight

Doc, I plan to build myself a new PC but before I do, please could you clarify M.2 support, as found in my Asus X99-E WS/USB 3.1 user manual?

"This motherboard features the M.2 slot, which shares bandwidth with PCI Express 3.0 x4 slot to speed up data transfer up to 32Gb/s. This helps enhance the performance of your SSD… that is dedicated only to the operating system."

My questions are:

- Is M.2 only useful when the operating system is installed on to one dedicated SSD?
- Is there any benefit to utilizing M.2 when the OS is installed on a RAID 10 array (across four 128GB Samsung 840 Pro SSDs)?
- I read online that enthusiasts install their OS (with a lot of hassle) directly on to the M.2-based drive. Does this offer the best performance compared to my alternative method?

Thank you very much for any help you can give.

–Jerry Franco, Jr.

THE DOCTOR RESPONDS: The maximum throughput of a modern SATA port is 6Gb/s, whereas a four-lane M.2 slot is theoretically capable of up to 32Gb/s. The fastest SATA-attached drives can push sequential transfers just over 500MB/s. Meanwhile, Samsung rates its 256GB and 512GB SM951-NVMe SSDs in excess of 2GB/s (both of these are M.2 drives).

To answer your first question, no, M.2 attached to the PCIe bus isn't only useful when it's hosting the operating system. However, many of your OS's operations are small and random in nature. That's exactly where a drive such as Samsung's SM951 excels. The NVMe interface is optimized for low latency, which translates to increased system responsiveness.

To use Be Quiet!'s SFX Power 2 with a full-sized ATX chassis, you need an adapter (which Be Quiet! doesn't include).

The best M.2 drives are faster than a striped set of mirrored SATA SSDs. What you lose, of course, is the redundancy of those mirrors. If this were the Doc's new PC, he'd drop a 256GB drive into the M.2 slot for Windows and his most performance-sensitive apps. Then, he'd repurpose the 840 Pros, perhaps leaving them in RAID 10 to store user data requiring some degree of protection. There's even room for a third tier of mechanical disks, should you need additional capacity.

Eating Up Bandwidth

Dear Doctor, I am currently working overseas in an area that shares its Internet connection with a large number of people. They restrict access in order to prevent the connection from becoming severely bogged down. We're allowed unlimited web browsing and email, and time-limited video chat.

Being away from my family is bad enough, but no online gaming is just cruel. I like to play *Battlefield 4, Star Wars Battlefront,* and *WoW.* From what I hear, though, online gaming consumes minimal bandwidth compared to other online activities. Is there a good reference for making such a comparison? Please help.

–Brian Eyestone

THE DOCTOR RESPONDS: The Doc doesn't have any benchmark data of his own to share with you, Brian. However, he does know that games utilize your Internet connection in different ways, and every title will chew up a different quantity of data per hour.

If you were to believe Cable One's web usage calculator (www.cableone.net/Docs/datacalculator.html), though, streaming music is more than twice as intensive as heavy gaming, and video streaming uses more than 50 times as much bandwidth. Most folks would probably be inclined to overestimate the bandwidth requirements of online gaming. Almost certainly, downloading the games themselves and keeping them up to date through patches would tax the connection more than a few hours of play time.

PSU Compatibility

Greetings Doctor, A while back, I bought a PSU for my sister's desktop. The stock unit died and I didn't pay enough attention when I picked out the replacement; it turned out to be an SFX form factor-based supply, rather than ATX. Do I simply need an adapter bracket, or is this specific PSU useless in her machine? Thank you for reading.

–Blake

THE DOCTOR RESPONDS: Many SFX-based power supplies include adapter brackets for applications just like this one. If yours didn't, then yes, that should be all you need to get the PSU installed. Check with the manufacturer to see if it offers a bracket. They're available on eBay as well.

Monitor Match

Doctor, I have a gaming rig and I'm looking for a 4K monitor, but I'm not sure which one to pick. Right now, I'm torn between the Asus PG279Q and Asus PG27AQ (or the Acer counterparts I've been reading about). Both employ IPS panels and support G-Sync. The PG279Q has a resolution of 2560x1440 and a refresh rate of 144Hz. The PG27AQ has a resolution of 3840x2160, but a refresh rate of only 60Hz.

My current system has a Core i7-3820 on an Asus Sabertooth X79, with 32GB of Corsair Vengeance DDR3 RAM, an Nvidia GeForce GTX 980, and an Asus VG236H 1080p monitor with a refresh rate of 120Hz.

First off, do I have enough under the hood to run both or either of these 4K monitors in a gaming situation? I play everything from first-person shooters to MMOs. What effect will the different refresh rates have on the experience? And finally, if I upgrade to the monitor with the lower resolution, will I notice much of a difference (graphically) compared to my current 1080p monitor? I'd appreciate any advice or suggestions you can give.

–Marc Rush

THE DOCTOR RESPONDS: When somebody makes reference to a 4K monitor, they're specifically talking about a screen with a resolution of 3840x2160. As of right now, there are actually no 4K panels capable of 120Hz refresh rates—that combination will require the bandwidth of DisplayPort 1.3 (together with a sufficiently fast graphics subsystem).

That being the case, what you are really asking here is whether you should go with a 27-inch G-Sync-capable display with a native resolution of 2560x1440 and a maximum refresh rate of 165Hz, or a 27-inch G-Sync-capable display with a native resolution of 3840x2160 and a maximum refresh rate of 60Hz.

The Doc loves 4K and would wholeheartedly recommend it for immersive gaming. However, you would need another GeForce GTX 980 in SLI to get fast enough frame rates at 3840x2160. Quad HD—used to describe a native 2560x1440 resolution—is a much more appropriate pairing for your GM204 graphics processor. Adding Nvidia's G-Sync technology means that the rate at which your GPU outputs individual frames is matched by the panel, creating a fluidity that you will absolutely notice. Therefore, the PG279Q is a better match for your current configuration. ⏻

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UPGRADE YOUR MEMORY

Looking for the perfect memory upgrade? We've got your back

BY ALAN DEXTER AND ZAK STOREY

LET'S FACE IT, MEMORY isn't the sexiest component in your computer. It's not a beautiful polygon-rendering graphics card from the metallurgic factories of AMD or Nvidia. It's not a gigahertz-crunching, hair-tingling, multithreaded CPU. Nor is it a speed-freak of a PCIe SSD solution—M.2 or otherwise. It's memory. RAM. And if we're honest, while it's without doubt one of the most important cornerstones currently fixed within every PC system on the planet, it's simply not that exciting, nor particularly easy to understand—beyond the concept of capacity, of course.

That said, the questions we are asked here in the *Maximum PC* office most often tend to revolve around that volatile yet thought-provoking component. "How much RAM do I need?" and "What's the best upgrade for me?" Well, that's what we're here to find out.

RAM is by far the most over-hyped, confusing thing to get your head around when it comes to PC components. If you didn't know any better, marketing teams across the globe would have you believe that higher frequency memory is what you need. Similar to CPUs and GPUs, surely the faster your memory clock, the more powerful your PC? Couple that with the belief that more capacity equals better, and you're all set to throw yourself into the black abyss of wasting your hard-earned dollars on the wrong setup.

At long last, with the launch of Skylake, we've finally seen the full integration of DDR4 into the custom PC environment, both at consumer and pro-grade levels. And although this new generation of RAM has much higher frequencies and far lower power consumption as standard, the overall performance advantages in comparison to DDR3 pale into insignificance next to the improvements we saw when advancing from DDR to DDR2.

So what is it that makes memory tick? What should you be looking out for? And what does all that jargon mean? Read on....

BALLISTIX
ANARCHY
VIPER
BALLISTIX SPORT DDR4
DDR4
VENGEANCE LPX
DDR4
CORSAIR
SAVAGE DDR4
BALLISTIX SPORT DDR4

CAPACITY COMPLICATIONS

THE MOST OBVIOUS and easiest to understand memory specification is capacity. The more you have, the more use you can make of it. Or at least, that's the theory. In reality, it's entirely dependent on what you're doing and the programs you use. For instance, if you only intend to play games, 32GB of RAM is excessive. So let's go through a quick rundown of what capacity we recommend. Note that these figures are for general desktop work and play—there are plenty of special-use cases that have their own memory hogs, and many instances when you can get away with much less.

8GB

We now see this as the bare minimum for your average PC. If you want to build a solid gaming system, 8GB is plenty for pretty much every title out there, even at maximum settings. The vast majority of game rendering is done inside the GPU's dedicated VRAM, so having more than 8GB just for gaming is not worth it. If your requirements are more sober, 8GB also happens to be great for office PCs and basic workstations as well—we're talking Adobe Premiere Pro and Photoshop levels here. If you're opening massive Excel spreadsheets and 10 to 20 Google Chrome tabs at a time, 8GB goes a long way to securing a trouble-free PC experience. Of course, you can use any of these applications with less than this—4GB would technically be OK for a light office PC, but we'd be surprised if you can even find 4GB kits for sale.

16GB

This is the sweet spot for streamers, YouTubers, and more serious digital artists. Admittedly, you can still do most of that on an 8GB setup, but if you're massively into gaming, and fancy delving into the murky world of online entertainment, or just gorging yourself on more than enough memory for your super-large artworks, this is the place to start. We recommend 16GB for the likes of Adobe After Effects and Premiere Pro, using 4K footage or videos longer than one hour. Out of Adobe's suite, these tend to be the more storage-intensive applications, After Effects more so than Premiere—though it's still rare to see it use more than 16GB of memory. That said, you should make sure you have the processing power to back it up. An Intel Core i7-6700K or 5820K, for example, will be plenty to sate your YouTubing ambitions.

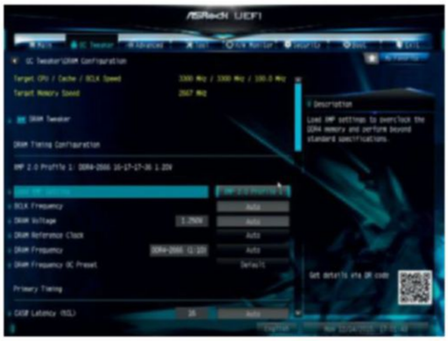
32GB

Once you reach these capacities, unless you're heavily into 3D modeling, you're honestly not going to gain much out of it. 32GB and beyond is great for massive 3D renders in Cinema 4D or 3DS Max, but anything else? Honestly? Probably not. The only other solution you could apply to this quantity of memory is to utilize half of it as a RAM disk. Programs such as Asus's RAM Cache or ASRock's RAMDisk help store temporary files, the scratch disk, and other speed-sensitive data on your DIMMs, instead of the primary storage solution in your system, allowing far faster reads and writes. Admittedly, it is great to have this additional space for video rendering, but unless you're profiting from your work, at this price point you'd be better off dumping more funds into other more system-critical components, such as the CPU or the GPU.

TIMINGS AND LATENCY

CAPACITY ASIDE, there are two figures you need to consider when choosing a new memory kit: its operating speed and the latency of those modules. It's easy to assume a lot from these figures individually, but you need to consider them together to get a true picture of what they are capable of. Roughly speaking, you want fast modules and low latencies, but neither is worth pursuing to extremes—as we'll see.

When talking about latency, there is a whole bunch of numbers that define how fast any given stick of memory operates, but the most useful one to highlight is the module's CAS latency. This tends to be advertised after the module's frequency, even if you're not immediately given all of the latency settings (it's always the first if they are fully listed). Standing for Column Address Strobe (or Common Address Strobe, depending on who you talk to), this figure tells you how many clock cycles it takes the module to access a particular memory location and get the output ready for transfer. For modern DDR4 DIMMs, you can expect these latencies to be in the range of 15–20 clock cycles.



You need to configure any RAM you add to your PC using the CMOS configuration tool.

The latency on its own doesn't actually tell you that much, at least not without knowing the speed at which the modules are running. And even here it can be a bit confusing, partly because DDR4 transfers several memory requests at the same time, and also because how manufacturers label RAM has gone through a lot of changes over the years. The end result is that you'll rarely see the actual operating frequency of memory quoted in MHz, with million transfers per second (MT/s) being the preferred measurement. Once you do have your CAS latency and your transfer speeds, you can ascertain the module's latency in

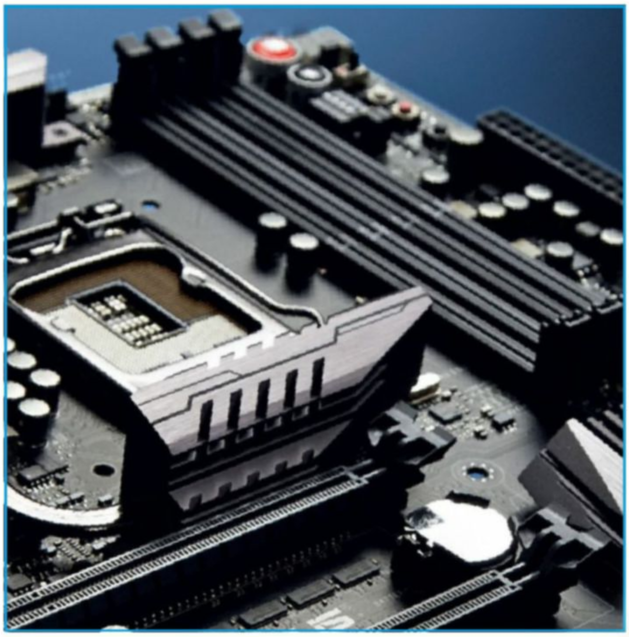
RAM LATENCIES

Technology	Transfer Rate (MT/s)	CAS Latency	Real Latency (ns)
SDR	100	2	20.00
SDR	166	3	18.07
DDR	200	2.5	25.00
DDR	400	3	15.00
DDR2	400	5	25.00
DDR2	800	5	12.50
DDR3	800	9	22.50
DDR3	2,400	11	9.17
DDR4	2,133	15	14.06
DDR4	3,200	16	10.00

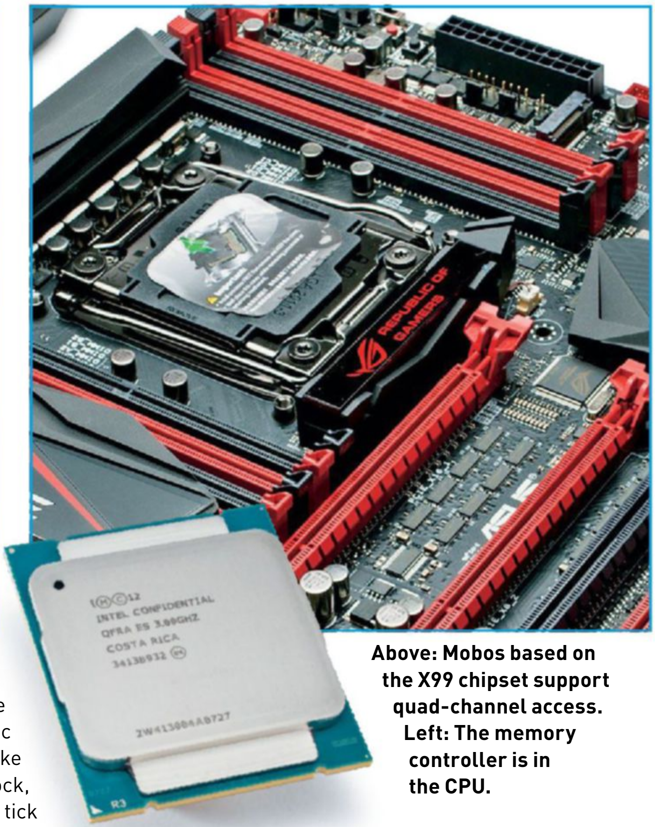
VENGEANCE
LPX
DDR4

64/128GB

At this point, you're just satisfying your epeen. It's true, 128GB of memory is commercially available—in fact, Corsair sells both Vengeance LPX and Dominator Platinum kits at this capacity—but it is years and years ahead of any mainstream desktop application or process that we have available to date. We can't even pretend it's viable for future-proofing yourself, because by the time programs begin to use this amount of memory, we'll have moved on to far more impressive memory standards. Ultimately, even if you were to run nine virtual machines on a daily basis, you still wouldn't be able to justify the cost. And if you're thinking of using this to run simulations, you'd be far better off using a couple of Xeon cores and some ECC-registered DIMMs. Mostly server structure technology, as opposed to a dedicated workstation, anyway.



Intel's Z170 chipset supports dual-channel memory access.



Above: Mobos based on the X99 chipset support quad-channel access. Left: The memory controller is in the CPU.

real-world terms (lower is better), by using the formula:

Latency = 2,000/RAM speed x CL

Note that for DDR4, you can ascertain the transfer rate from the module's label—you're looking for something similar to PC4-2400. When you've got the transfer speed and have found the latency, you can work out the real-world latency in seconds. So, for example, if you were to take a PC4-2400 module with a CAS latency of 14, you'd get:

Latency = 2,000/2,400 x 14 = 11.67ns

It's worth doing these calculations to see how various memory kits compare, as it isn't always obvious. It's also interesting to see how timings have changed over the years—take a look at the table on the previous page. This covers the various technologies that have underpinned consumer memory since standard SDRAM. Note that as speeds have increased, so the real-world latencies have continued to drop.

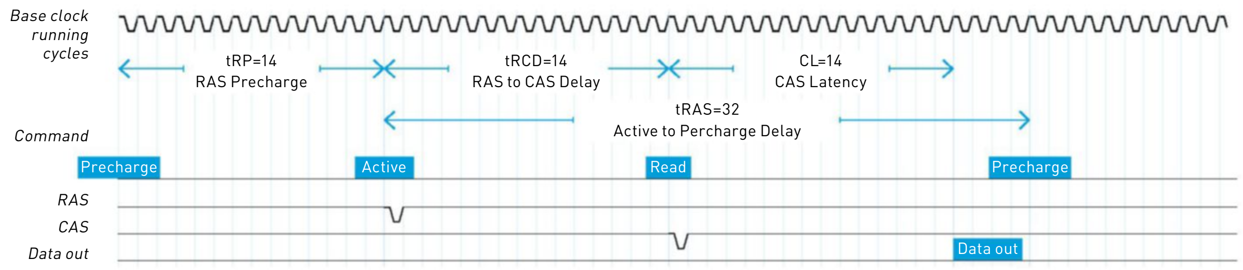
Speaking of hertz, it's important to understand that every single component in your machine operates at a specific frequency. Rather like the cycling of a clock, these frequencies tick and tock with a negative and a positive downstroke or upstroke.

Way back in the early days of personal computing, SDRAM only registered data transfers on the rising pulse of each clock cycle. Double data rate SDRAM (DDR SDRAM), however, changed this by operating on both the rise and fall of the clock pulse, increasing standard performance two-fold at the time. This technology has underpinned computer memory timings ever since.

Even here, things aren't quite as straightforward as they could be, and this is due to how we report frequencies. Back before we made the move to DDR (double data rate) RAM, the quoted frequency was legitimate. In order to show that DDR was faster, though, manufacturers often doubled the quoted frequencies, which was somewhat confusing, and not strictly true. Even now, some websites will report DDR4 modules running at 3,000MHz, when in truth the memory clock actually runs at half that speed.

If you've been building your own computers for a while now, you'll be aware that when a new memory technology is released, the transfer speeds tend to be fairly low, while the latencies tend to be higher. This is why the outgoing memory standard tends to offer better speeds than the newer, often more expensive, technology. It doesn't take long for this to even out, though, and that's where we are with the latest DDR4 modules. Now is a good time to buy, in other words.

Timing Diagram of DDR4 SDRAM 14-14-14-32



Real-world latencies have remained fairly consistent, but the number of clock cycles all those commands take certainly adds up.

STANDARDS

ANY STICK OF RAM can operate at a number of frequencies and latencies, depending on the platform you use it on. Which settings it uses is defined in your UEFI/BIOS configuration utility, although in order to get your system up and running, your motherboard should default to the settings defined by a small chip on the RAM, called the serial presence detect (SPD for short). These settings adhere to the JEDEC standard, and don't necessarily set your memory as fast as it can go, although they should ensure that it boots fine. JEDEC defines the standards for memory performance, and ensures that there's common ground for RAM manufacturers and motherboard makers to adhere to. The problem is, JEDEC errs on the safe side a little too much for the more enthusiast-level memory makers. The table below shows the JEDEC specifications for DDR4, and it's hardly redefining speed. To be fair, though, that isn't really its job. It's there to ensure compatibility first and foremost.

If you do have some high-speed memory, you'll need to pop into your BIOS to ensure that your memory is operating at the right speed. For Intel platforms, the timings for the memory are defined by the XMP settings for that memory, while the AMD alternative is AMP. These basically set the timing and frequency settings for your memory, and you need to pick the quickest setting for your platform. You can configure the settings yourself as well, if you'd prefer. How you do this depends on your motherboard so, as always, check the manual for details.

Now you know how to read memory labels, pick the right amount of RAM for your system, and understand latencies, we can look at which sticks are worth considering. Turn the page to find your perfect RAM kit.

JEDEC STANDARDS FOR DDR4 MODULES

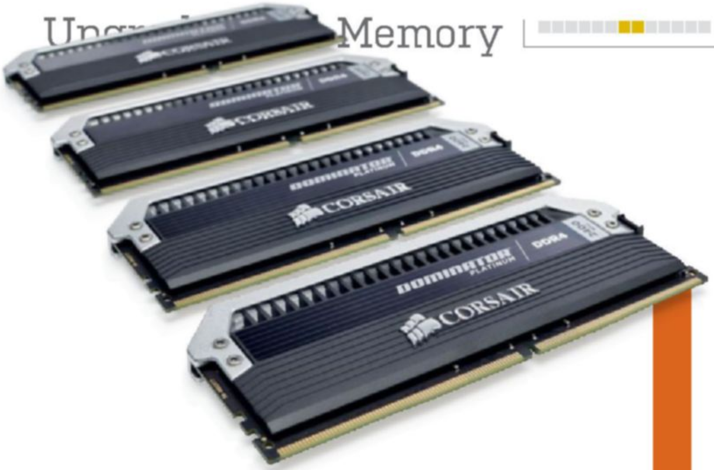
Standard Name	Data Rate (MT/s)	Module Names	CAS Latency	Real Latency (ns)
DDR4-1600J	1,600	PC4-1600	10	12.50
DDR4-1600K			11	13.75
DDR4-1600L			12	15.00
DDR4-1866L	1,866	PC4-1866	12	12.86
DDR4-1866M			13	13.93
DDR4-1866N			14	15.01
DDR4-2133N	2,133	PC4-2133	14	13.13
DDR4-2133P			15	14.06
DDR4-2133R			16	15.00
DDR4-2400P	2,400	PC4-2400	15	12.50
DDR4-2400R			16	13.33
DDR4-2400U			18	15.00

CHANNEL LIMITING

THE NUMBER of memory channels supported by a processor's memory controller dictates the overall bandwidth available. All modern APUs and CPUs support at least dual-channel memory access, while Intel's "enthusiast" chips (we're looking at you, Haswell-E powered Core i7-5960X) double that up to quad-channel configurations. Multiple memory channels enable the processor to read and write to several DIMMs at the same time, increasing the overall memory bandwidth available. In order to hit the optimal performance, you need to actually populate those channels, though, and that isn't always the case—particularly at the budget end of the spectrum. All too often, we see the most-affordable machines and laptops ship with a single DIMM (or SoDIMM), thus limiting the potential performance available. To paint a silver lining to this cloud, though, it does mean that any memory upgrade you do perform will improve throughput and responsiveness significantly.

SISOFT SANDRA BENCHMARKS

Channels	Bandwidth
Quad-Channel	45.4GB/s
Dual-Channel	28.5GB/s
Single-Channel	14.5GB/s



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By far the king of cool

SINCE THEIR INTRODUCTION to the world stage, Corsair's Dominator Platinums have been more than mere memory. They are the pinnacle of artistic design and double data rate applied sciences. A symbol of the elite when it comes to computational superpower.

This is mostly due to the phenomenal price tag that's often associated with these sticks of DDR3/4. Today, however, that's not the case, and although they're not the cheapest option here, they're far from the most expensive. So for $300 you net yourself 32GB (or 4x 8GB) of the sleekest, most dependable, quad-channel memory out there. With a CAS latency of just 14, and a data rate peaking at 2,400MT/s these DDR4 sticks dominate the performance side of things, at least when it comes to 7-Zip's archival benchmarking test. This is in no doubt thanks to their increased capacity. And on top of that? They also provide some pretty nifty power savings, too.

Interestingly, if you do fancy pushing the boat out that little bit further, you can opt for the second lot of XMP settings in your BIOS. This ramps the data rate up to 2,666MT/s, and the voltage up by another 0.15V. However, you'll be adding another 52W directly on to your electricity bill from that mediocre voltage increase—and it's probably not worth it in the long run.

VERDICT
9

Corsair 32GB Dominator Platinum 2,400MHz

+ M-M-M-MONSTER KILL Stunning design; solid performance; strong latencies; light bar customization; average price to capacity ratio.

− FIRST BLOOD A bit pricey; tall.

$300, www.corsair.com

SPECIFICATIONS

Manufacturer Code	CMD32GBX4M4A2400C14
Capacity	32GB (4x 8GB)
Data Rate	2,400MT/s
Timings	14-16-16-31
Channels	Quad-channel
Voltage	1.2V
Heatsink	Yes
Warranty	Limited lifetime

Corsair 16GB Vengeance LPX 2,666MHz

Making the right cuts

CORSAIR'S VENGEANCE LP series has always been designed around one simple concept: fitting into places where other DIMMs fear to tread. They achieve this admirably, capable of fitting under even the meatiest of air-cooling supertowers or low-profile ITX coolers. This helps to create a trouble-free HTPC build experience.

With the launch of Skylake and Haswell-E, Corsair introduced the LPX series. The "X" denotes the jump to DDR4. To date, these have been Corsair's finest DDR4 sticks, most notably because they're not held back by the huge price barrier of the Platinums.

Although they pale in the shadow of the Dominators' glory, these particular dual-channel memory kits still maintain a sleek and sexy feel, hidden out of sight and out of mind. With an all-black aluminum heatsink, and black PCB, you can't go wrong here. Although they lack the archiving prowess of the Platinums, thanks to a lower overall capacity and slightly more sluggish real-world latency, they still hold their own in almost every other benchmark. And because of the dual-channel setup, these little devils also require less power. The only downside? Well, they sit on the simple side of design, and if you're thinking of throwing these underwater, they're not the easiest heatsinks to remove, either.

VERDICT
8

Corsair 16GB Vengeance LPX 2,666MHz

+ LIMBO CHAMPION Good dollar-to-gigabyte ratio; sleek; low profile; solid performance.

− GRANDMA'S ARTHRITIS Simple; slower latencies than the Dominator Platinums; anonymous appearance.

$115, www.corsair.com

SPECIFICATIONS

Manufacturer Code	CMK16GX4M2A2666C16
Capacity	16GB (2x 8GB)
Data Rate	2,666MT/s
Timings	16-18-18-35
Channels	Dual-channel
Voltage	1.2V
Heatsink	Yes
Warranty	Limited lifetime

Corsair 16GB Vengeance LPX 3,200MHz

Overclock for an underclock?

NOW WE COME TO the pinnacle of what Corsair can provide—it's in the interesting offering of these 3,200MT/s Vengeance LPXs that we find the current peak of consumer DDR4 technology. Complete with included air-cooler and crazy XMP settings, this memory kit throws the JEDEC standards out of the window, ramping up the overall voltage to 1.35V, and the memory transfer rate all the way from 2,133 to 3,200MT/s. Although it's not as simple as that....

To pass the 2,800MT/s mark, memory manufacturers have to tinker with the BCLK. In the Z170 chipset, this isn't a big deal, as the memory BCLK is separate from the CPU. However, this is a quad-channel kit, designed to work with the X99 platform, which doesn't have such a robust and dynamic memory controller. The XMP settings required to reach 3,200MT/s change the BCLK from 100 to 120MHz. The i7-5820K we use for our testing goes from a 3.3GHz clock up to 3.96GHz. What you'll often find is that your system will declock itself in an attempt to boot, and you'll have to overclock it yourself back up to stock. Unfortunately, we couldn't reach those stable stock frequencies while maintaining the memory at 3,200MHz, and all we could achieve was a mere 2.8GHz.

VERDICT **6**

Corsair 16GB Vengeance LPX 3,200MHz

⊞ **POWER** Insanely high frequency; heatsink fan included; low profile; will operate at lower data rate; fine with Z170 minus bandwidth.

⊟ **WHAT CPU?** Underclocks CPU; huge consequential performance hit; unstable when CPU pushed to stock.

$165, www.corsair.com

SPECIFICATIONS

Manufacturer Code	CMK16GX4M4B3200C16R
Capacity	16GB (4x 4GB)
Data Rate	3,200MT/s
Timings	16-18-18-36
Channels	Quad-channel
Voltage	1.35V
Heatsink	Yes and cooler
Warranty	Limited lifetime

Crucial 16GB Ballistix Elite 2666

No silly MHz rating here

CAN YOU GUESS WHY Crucial is already on the right foot with us? It's for one reason and one reason alone: it isn't trying to impress us with any obscure MHz ratings. Thanks, Crucial, for being the honest Joe in the memory milieu. The Ballistix Elites have been around for quite some time. Many of you will remember the early days of the super-huge heatspreaders that were found in the DDR3 variants. Well, those times are long past and—hot damn—look at these little beauties! The Crucial Ballistix Elites are some of the sexiest, sleekest and downright slinkiest all-black RAM modules out there. With a powder coat finish, they look perfect in almost any build.

And as for performance? Well, that's another matter. Short of Corsair's "3,200MHz" monsters, and Kingston's soul-destroying Savages, they work out as the third-most expensive memory kit in this roundup. But, unfortunately, they only sit at a simple 2,666MT/s, with a CAS latency of just 15, meaning they operate just a micron faster than the Dominator Platinums, yet cost 50 cents more per gigabyte. Ultimately, however, performance is pretty standard across the board, and you're not likely to see a huge disparity between memory kits, so if you don't mind the hefty cash outlay, this is a fair kit to invest in.

VERDICT **8**

Crucial 16GB Ballistix Elite 2666

⊞ **MENTAL** Great design; black PCB; solid performance; fairly good power consumption; good latencies.

⊟ **PLACID** Pricier per gigabyte than Dominator Platinums.

$158, www.crucial.com

SPECIFICATIONS

Manufacturer Code	BLE2K8G4D26AFEA
Capacity	16GB (2x 8GB)
Data Rate	2,666MT/s
Timings	16-17-17-36
Channels	Dual-channel
Voltage	1.2V
Heatsink	Yes
Warranty	Limited lifetime

Crucial 16GB Ballistix Sport 2400

Cheap and cheerful!

CRUCIAL'S BALLISTIX SPORT quad-channel set was actually one of the first kits we got in for the new DDR4 memory standard. It certainly provided us with a convenient testbed for benchmarking many a new processor and graphics card. And as far as value for money goes, it's easily the best in this group test, costing just $6.56 per gigabyte. Despite the rather generic design style on the heatsinks, the black PCB makes this particular set of DDR4 ideal for liquid cooling. Even if you don't want to ride those watery waves to lower-temperature heaven, well, the black PCB at least adds a modicum of moodiness.

As for performance, try this for intrigue. This quad-channel kit pulls pretty much the same power from the wall as the Ballistix Elites, a dual-channel effort. Overall, the benchmark scores are a little lower than many of the other kits in this roundup, but for everyday usage and video rendering, you can guarantee it won't have much impact on your render times. The real-world latency registering at 12.5ns isn't ideal either, but again, you really won't notice much improvement by chunking out for a more expensive kit of RAM, beyond capacity, at this point.

VERDICT 9

Crucial 16GB Ballistix Sport 2400

+ **KOBE BRYANT** Great value for capacity; easy to watercool; black PCB; good performance; low wattage; did we mention cheap?

− **JAVARIS CRITTENTON** Bland design; lowest performer in this roundup; early iteration of DDR4; mediocre appearance.

$105, www.crucial.com

SPECIFICATIONS

Manufacturer Code	BLS4K4G4D240FSA
Capacity	16GB (4x 4GB)
Data Rate	2,400MT/s
Timings	16-16-16-39
Channels	Quad-channel
Voltage	1.2V
Heatsink	Yes
Warranty	Limited lifetime

Crucial 16GB Ballistix Sport LT 2400

White camo RAM? We're in!

THERE'S NOTHING LIKE COLOR-MATCHING your build perfectly. Having all of your components correctly correlate in a windowed chassis just feels right—it feels good. After all, when you're choosing your memory kit, there's often not a great deal between them, as you can tell from this group test. More often than not, it's what's affordable, available, and looks best in your build that matters. And this is a market that Crucial is tapping into with these fantastically white Ballistix Sport LT DIMMs.

However, beyond aesthetics, there's not a lot here that differentiates them from Crucial's other "sporty" offerings. They're still rated at 2,400MT/s, and they're still available up to 16GB-worth of DDR4 capacity. Other downsides? Well, you're back to dual-channel, and you still keep that sadly sluggish CAS latency of 16ns, resulting in 13.33ns recurring real-world sloth.

As far as performance goes, they're within 5 percent of almost all the other kits (bar the 32GB monstrosities that are Corsair's Dominator Platinums), though they do come joint first with the Patriot Viper Red 2x 8GB for power draw, pulling a total of 160W from the wall. Beyond all that, the only other perks are that white PCB and the similarly desaturated heatsink. That's all there is to it. Fancy a snowy build? Then bag these beasties.

VERDICT 7

Crucial 16GB Ballistix Sport LT 2400

+ **ABOMINABLE SNOWMAN** Awesome design; white PCB; low power draw.

− **SNOW WHITE** Standard performance; lower CAS latency.

$108, www.crucial.com

SPECIFICATIONS

Manufacturer Code	BLS2K8G4D240FSB
Capacity	16GB (2x 8GB)
Data Rate	2,400MT/s
Timings	16-16-16-39
Channels	Dual-channel
Voltage	1.2V
Heatsink	Yes
Warranty	Limited lifetime

Kingston 16GB HyperX Savage Black 3,000MHz

Savage—but not in your face

AHH—AT LAST we get to the absolute kings of speed. If you've already read about the Corsair Vengeance LPX 3200s, no doubt you'll understand the problems associated with breaking that 2,800MT/s threshold. It's difficult if you're not adjusting the BCLK to any great degree. Fortunately, Kingston's BCLK adjustments are far less severe than their Corsair counterparts, and we managed to overclock our Intel Core i7-5820K back up to its standard stock frequencies, with very minimal changes to the overall VCore or other settings nestled deep within the UEFI BIOS. And with that we saw some awfully impressive numbers.

With a CAS latency of 15, the real-world latency of these Savages drops to 10ns, on a par with Corsair's 3200 kit. And coupled with that stock CPU overclock, it's by far the fastest memory in this group test. Because of that, we saw some phenomenal archiving benchmark results: a mind-blowing 386MB/s extraction in 7-Zip, and an impressive 31.5GB/s in SiSoft Sandra's memory bandwidth benchmark—more than any other dual-channel kit. The downside is that astronomical power draw. At 257W for a dual-channel kit, it outstrips even the quad-channel kits for power requirements.

VERDICT

9

Kingston 16GB HyperX Savage Black 3,000MHz

⊞ **SAVAGERY** Phenomenal dual-channel performance; fastest real-world latency available; outperforms all 16GB kits; looks good.

⊟ **TIMIDITY** Pricey; limited overhead for CPU overclocking ability; have to adjust baseclock manually.

$165, www.kingston.com

SPECIFICATIONS

Manufacturer Code	HX430C15SBK2/16
Capacity	16GB (2x 8GB)
Data Rate	3,000MT/s
Timings	15-16-16-39
Channels	Dual-channel
Voltage	1.35V
Heatsink	Yes
Warranty	Lifetime

Patriot 16GB (2x 8GB) Viper Red 2,400MHz

Rouge and ready to roll

PATRIOT HAS PROVIDED some fantastic memory kits over the last few years. Certainly, the Patriot Viper Blacks were some of the crispest low-profile DDR3 kits we'd ever laid eyes on. So with the launch of DDR4, we only expected good things from the Californian memory manufacturer.

And here we have it: Patriot's new line of Viper Reds coming in at a snug 2,400MT/s, and a CAS latency of 15. Although they are not the fastest memory out there (in fact, they're the slowest in our group test), they do provide dependability and good value for money. In fact, they're a solid $7.50 per gigabyte. As far as performance goes, however, they're pretty much where you'd expect a standard DDR4 kit to be. Their overall bandwidth is the lowest out of our testing, at 28.3GB/s. But you do benefit from a fantastically low power draw of only 160W from the wall—one of the lowest here.

If you're after a kit of red RAM for your system, and are only focused on gaming and aesthetics, these would be a fine choice. The 16GB won't let you down where it counts, and you won't see any negative effects from purchasing such low latency coupled with a comfortable data rate.

VERDICT

8

Patriot 16GB (2x 8GB) Viper Red 2,400MHz

⊞ **JOHN MCCLANE** Nice aesthetic design style; ideal for gaming; great power draw.

⊟ **PEE-WEE HERMAN** Slowest benchmarks; high real-world latency; not fantastic price to capacity ratio.

$120, www.patriotmemory.com

SPECIFICATIONS

Manufacturer Code	PV416G240C5K
Capacity	16GB (2x 8GB)
Data Rate	2,400MT/s
Timings	15-15-15-35
Channels	Dual-channel
Voltage	1.2V
Heatsink	Yes
Warranty	Limited lifetime

Patriot 16GB (4x 4GB) Viper Red 2,400MHz

Even more red for your redness

WE'VE ESTABLISHED that the 2x 8GB kit (previous page) is pretty good value for money. And although the benchmarks don't stack up particularly well in comparison to some of the more powerful offerings, they're more than ideal for any gaming rig. So how does the quad-channel kit compare?

Well, you still get that same 2,400MT/s, you still get the CAS latency of 15, and you still get the same capacity as the 2x 8GB. The only difference is the increase from dual- to quad-channel. Ultimately, however, you don't gain a lot in regard to performance. There's the additional bandwidth. But that doesn't translate to any real-world benefit in our testing, with most, if not all, of our benchmarks being within 1 percent of their 2x 8GB twins. One thing that constitutes an improvement is the dollars-per-gigabyte metric, which at $6.88 is among the best here. But you end up paying for that with an additional 20W power draw out of the wall, compared to those dual-stick Patriots. It's a difficult call to make. If power costs don't worry you, these are technically better value. And it's hard to deny how much nicer a system looks with four sticks, in comparison to two. Even so, in the long term, that extra wattage will cost you.

VERDICT **7**

Patriot 16GB (4x 4GB) Viper Red 2,400MHz

⊞ **PIT VIPER** Solid value for money; standard performance; good design.

⊟ **EARTHWORM** Little wow factor; performance is nothing special; higher power requirements than dual-channel kit.

$110, www.patriotmemory.com

SPECIFICATIONS

Manufacturer Code	PV416G240C5QK
Capacity	16GB (4x 4GB)
Data Rate	2,400MT/s
Timings	15-15-15-35
Channels	Quad-channel
Voltage	1.2V
Heatsink	Yes
Warranty	Limited lifetime

PNY 16GB Anarchy X 2,800MHz

Almost the best bang for buck

PNY'S ANARCHY X kits are some of the more interesting DDR4 kits we've had the opportunity to test for this roundup. They fit snugly at the high end of the overclocking spectrum, without having to alter the BCLK to any vast degree. This means we can get some phenomenal benchmarks with the X99 platform, without necessarily having to re-overclock our CPU to stock again. In fact, we can increase the overall performance in our system with a fairly conservative overclock to the CPU on top of that as well.

And it's a noticeable difference with a stock CPU, with the highest PCMark 8 Creative score, and some solid archiving performance in both WinRAR and 7-Zip. These sticks fit right into the sweet spot—they're not the slowest, nor the fastest memory kit out there. It's a pretty middle-ground kit when it comes to latency as well. Couple that with a fairly meaty power draw (if not actually the highest), and we're on to a winner. Why? Well, it's only $6.88 per gigabyte. And for that performance at that price, it's truly unmatched.

The only thing that may put you off is that unusual design incorporated into the heatsinks—it looks as though PNY has fallen into the trap of thinking "gamers like red, pointy things," which is disappointing. Other than that, though, there's not a lot we can criticize about the Anarchy X kit.

VERDICT **9** KICK ASS!

PNY 16GB Anarchy X 2,800MHz

⊞ **JAX TELLER** Great price per gigabyte; huge bandwidth; nifty frequency; very good performance.

⊟ **POPE FRANCIS** A little power-hungry.

$110, www.pny.com

SPECIFICATIONS

Manufacturer Code	MD16GK4D4280016AXR
Capacity	16GB (4x 4GB)
Data Rate	2,800MT/s
Timings	16-16-16-36
Channels	Quad-channel
Voltage	1.2V
Heatsink	Yes
Warranty	10 years

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HOW WE TESTED

When it comes to memory testing, finding the right setup is crucial. After all, there's no point testing quad-channel kits on a Skylake platform. For this we cracked out a few old favorites: Intel's Core i7-5820K, ASRock's X99M Extreme4, and one GeForce GTX 980, all running on Windows 10, installed on Samsung's 512GB 950 Pro SSD. On top of that, we wanted to prove once and for all that as long as you have 8GB, memory frequency, latency, and channels don't matter for gaming, so *Shadow of Mordor* was top of the testing list. Couple that with Cinebench for rendering performance, WinRAR and 7-Zip for archiving performance, and PCMark 8 for creative overall analysis, and we were good to go.

BENCHMARKS

	Corsair 32GB Dominator Platinum 2,400MHz	Corsair 16GB Vengeance LPX 2,666MHz	Corsair 16GB Vengeance LPX 3,200MHz	Crucial 16GB Ballistix Elite 2666	Crucial 16GB Ballistix Sport 2400
PCMark 8 Creative Test *(Index)*	4,858	4,849	3,247	4,850	4,819
Cinebench R15 *(Index)*	1,020	1,024	820	**1,026**	1,008
Minecraft 1.7.10 *(fps)*	197	184	171	193	190
Shadow of Mordor @ 4K *(fps)*	**27**	**27**	**27**	**27**	**27**
SiSoft Sandra Bandwidth Test *(GB/s)*	44	30.9	40.3	30.7	40.2
WinRAR Benchmark *(MB/s)*	15	16	14	16	15
7-Zip Benchmark Test *(Time in minutes)*	**1:34**	2:43	3:11	2:42	2:48
Prime 95—Power Draw Peak *(Watts)*	188	178	219	179	178
Real Latency *(Nanoseconds)*	11.67	12.00	**10.00**	11.25	12.50
Price Per Gigabyte	$9.38	$7.19	$10.31	$9.88	**$6.56**

BENCHMARKS

	Crucial 16GB Ballistix Sport LT 2400	Kingston 16GB HyperX Savage Black 3,000MHz	Patriot 16GB (2x 8GB) Viper Red 2,400MHz	Patriot 16GB (4x 4GB) Viper Red 2,400MHz	PNY 16GB Anarchy X 2,800MHz
PCMark 8 Creative Test *(Index)*	4,824	4,896	4,823	4,817	**4,938**
Cinebench R15 *(Index)*	1,005	1,006	1,005	1,008	1,007
Minecraft 1.7.10 *(fps)*	207	**253**	191	187	210
Shadow of Mordor @ 4K *(fps)*	**27**	**27**	**27**	**27**	**27**
SiSoft Sandra Bandwidth Test *(GB/s)*	28.3	31.5	28.3	40.9	**46.4**
WinRAR Benchmark *(MB/s)*	15	**17**	15	15	16
7-Zip Benchmark Test *(Time in minutes)*	2:50	2:17	2:54	2:45	2:37
Prime 95—Power Draw Peak *(Watts)*	**160**	257	**160**	179	245
Real Latency *(Nanoseconds)*	13.33	**10.00**	12.50	12.50	11.43
Price Per Gigabyte	$6.75	$10.31	$7.50	$6.88	$6.88

Best scores are in bold. Overall winner is highlighted.

And the winner is…

PNY 16GB Anarchy X 2,800MHz

MEMORY IS ONE OF THE MOST DIFFICULT components to benchmark with a view to truly useful analysis. The problem is that, for the vast majority of specs, increased frequencies and lower CAS latencies don't affect gaming in any significant way. We know that not everyone here is a gamer, but the fact is that the vast majority of the PC enthusiast audience plays games first and foremost, as opposed to anything else. Across our entire suite of benchmarks, over 10 separate memory kits, ranging from 8GB all the way up to 32GB, from 2,133MHz to 3,200MHz, from dual-channel to quad-channel, our *Shadow of Mordor* benchmark did not change whatsoever, hitting an average of 27fps each and every time we ran it. And even if you're more interested in the creative utilities found within the digital world, just take a look at our PCMark creative benchmarks—the only kit that struggled to any great degree did so because of a reduced clock speed on the CPU, rather than any memory-related matter.

So with all of these convoluted and confusing memory specs, and budget-busting DRAM sticks, which one do we think is best for your wallets and your next build? To be honest, it's not the cheapest, it's not the best-looking, nor is it the best-performing. But the PNY 16GB Anarchy X 2,800MHz is the best kit you can buy at the moment. Why so? In short, it manages to hit the sweet spot in almost every scenario. It performed highest in our PCMark Creative test, and it held its own in Cinebench alongside the rest of our group test's participants. Its performance in memory bandwidth, WinRAR archiving performance, and 7-Zip was essentially flawless. And although the wattage wasn't great, especially for the MT/s it was achieving along with the bandwidth, it was at least quite competitive. But the biggest factor is the price. You can grab a set of these for only $110. That's $6.88 per gigabyte, and that makes all the difference when the performance metrics are so tight. For the average user, these are the best sticks money can buy. And if you really want to push the boat out, PNY offers a similar set of DDR4 with a phenomenal 2,933MT/s, and a CAS latency of 12 to boot. Rest assured, we won't sleep until we get a set of those into the office for the next issue of *Maximum PC.*

HONORABLE MENTION

That said, with all the frequencies, CAS latencies, and XMP settings on the planet to date, nothing compares to good old capacity for real-world performance. Regardless of all those benchmarks, Corsair's Dominator Platinums came a very close second in our testing. For looks, they're second to none, and for outright performance, 32GB provides a far greater benefit than any 16GB setup, certainly for archival purposes. Interestingly, they are still quite the heavy hitter when it comes to price per gigabyte as well. Although not as expensive as some of the higher frequency kits out there, and not as affordable as some of the other 2,400MT/s kits, they're still fairly well priced, certainly in comparison to when they were first launched. If you're after the very best experience, 64GB of these bad boys should be more than enough to sate your epeen appetite, and provide you with enough future-proofing for any revolutionary software and gaming advances that may appear within the next five years.

It's not the cheapest, the best-looking, or the best-performing—but the PNY 16GB Anarchy X 2,800MHz hits the sweet spot

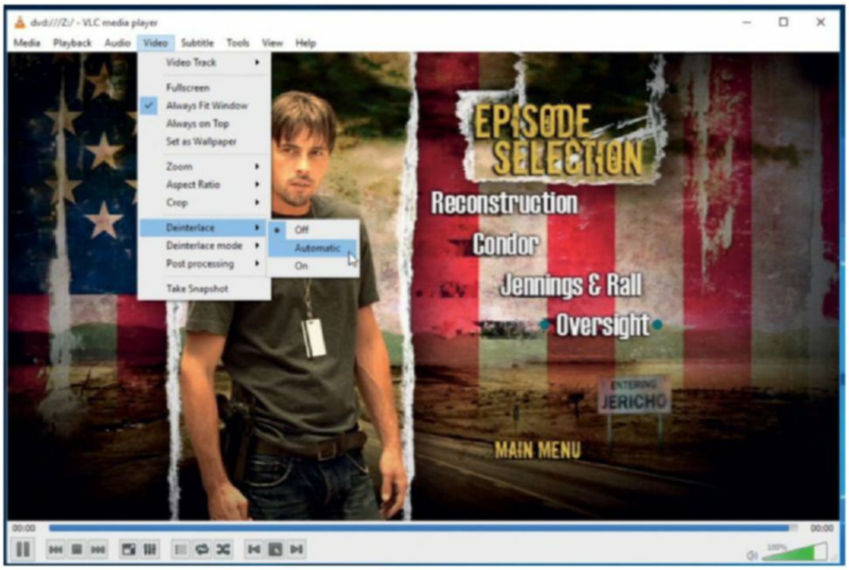
Fix WINDOWS 10

SOLVE THE MORE FRUSTRATING OVERSIGHTS AND PROBLEMS IN MICROSOFT'S LATEST AND GREATEST

BY NICK PEERS

WINDOWS 10 certainly blends the best features of Windows 7 and 8.1, but there are still hurdles to overcome if you truly want to enjoy it. In this feature, we round up the most frustrating annoyances you're likely to come across with your new operating system, and show you how to get the OS to work the way you want it to once again. You'll discover how to restore features taken out of Windows 10, such as Windows Media Center, make sure settings are correctly applied to protect your privacy and security, plus resolve other issues with the minimum of fuss.

Once you've worked your way through our list, you'll have a PC that's working for you, not the other way round. Without further ado, then, it's time to get Windows 10 firmly in line....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Automatic
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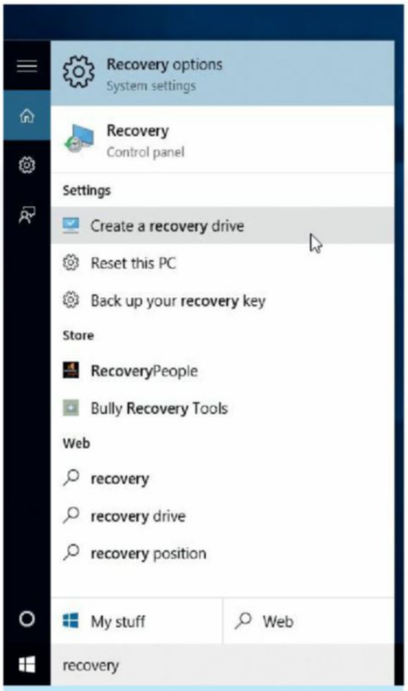
MAIN MENU

Watch DVDs Again

WINDOWS MEDIA PLAYER lost the ability to play DVD video in Windows 10 (as it did in Windows 8 before it). You can purchase Microsoft's Windows DVD Player for $15 from the Store, but why do that when VLC Media Player enables you to watch DVDs—including non-Region 1 discs—for free? Just download and install it from www.videolan.org/vlc. Before you play any movies, open the "Video" menu and choose "Deinterlace → Automatic" to improve the picture quality.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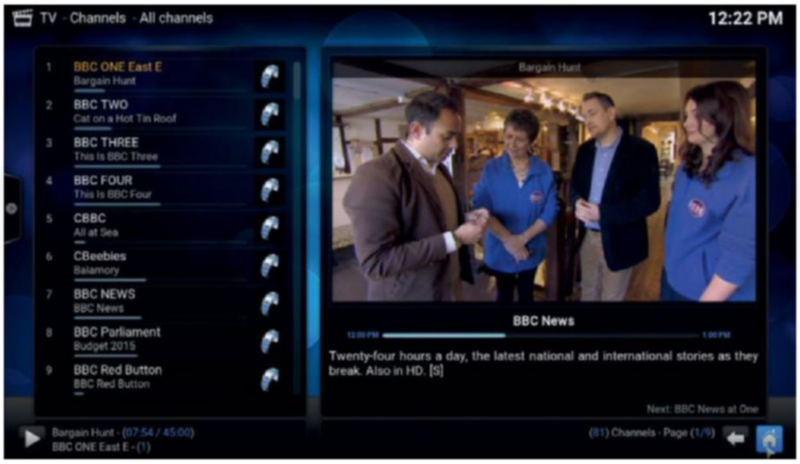
System settings
Recovery
Control panel
Settings
Create a recovery drive
Reset this PC
Back up your recovery key
Store
RecoveryPeople
Bully Recovery Tools
Web
recovery
recovery drive
recovery position
My stuff
Web
recovery

Prepare to Recover

WHAT HAPPENS IF Windows 10 fails to boot? You need a system recovery drive that gives you access to Windows 10's repair options. You can create a full-blown reinstall disc with these tools (see right) or you can press a spare 1GB USB flash drive into service instead with just the repair utilities in place. To do the latter, plug the drive into your PC, type "recovery" into the "Search" box, and click "Create a recovery drive" under "Settings." Untick "Back up system files to the recovery drive," and follow the prompts to create your drive. Should you need to use it, restart your PC with the drive plugged in to access the tools.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9 BBC Red Button
BBC Red Button
Bargain Hunt
BBC News
12:00 PM
1:00 PM
Next: BBC News at One
Bargain Hunt - (07:54 / 45:00)
BBC ONE East E - (1)
(81) Channels - Page (1/9)

Twenty-four hours a day, the latest national and international stories as they break. Also in HD. [S]

Replace Windows Media Center

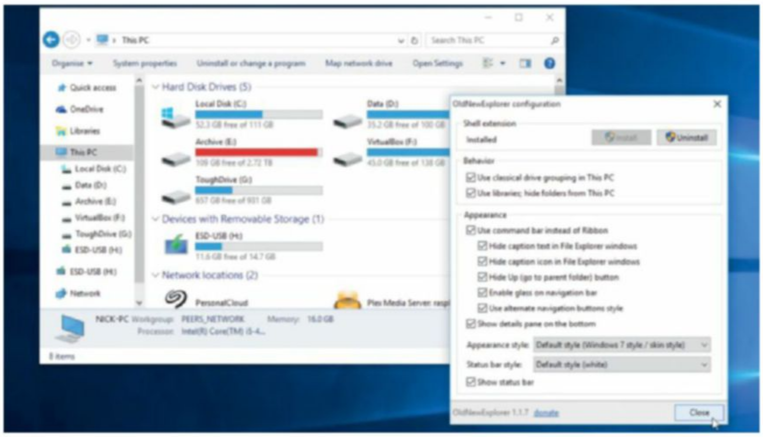
WINDOWS MEDIA CENTER has also been dropped from Windows 10. There are plenty of free alternatives, but our personal recommendation is Kodi (www.kodi.tv), which also has a built-in DVD player. If you have a TV tuner attached to your PC for watching and recording live television, you'll also need NextPVR (www.nextpvr.com), along with the CCCP pack (www.cccp-project.net). Visit http://kodi.wiki/view/NextPVR for a guide to pairing NextPVR with Kodi.

Create a Reinstall Disc

IT PAYS TO be able to reinstall Windows from scratch should you need to. You need a blank DVD or spare 8GB USB flash drive. First, download the Windows 10 Media Creation Tool from www.microsoft.com/en-gb/software-download/windows10—choose 32-bit or 64-bit depending on your system (press Windows-Pause/Break and look under "System" if you don't know). Launch the tool. Select "Create installation media for another PC," click "Next" and follow prompts to select your language, edition, and architecture (32-bit or 64-bit). Insert your USB flash drive, or create an ISO file you can then burn to a single DVD.

Save Bandwidth

WINDOWS 10 USES peer-to-peer technology to deliver Windows updates. This means your Internet connection is used to share updates you've downloaded with other users. If you're on a slow broadband connection, or you'd rather not let Microsoft do this, you can change it. Click "Start" and choose "Settings." Select "Update & Security," and click "Advanced options" under "Windows Update." Next, click "Choose how updates are delivered," and either switch the feature off or select "PCs on my local network" to further cut bandwidth usage by only sharing the updates between PCs in your home.


This PC
Search This PC
Open Settings
OldNewExplorer configuration
Install
Uninstall
Close
donate

Shell extension
Installed

Behavior
☑ Use classical drive grouping in This PC
☑ Use libraries; hide folders from This PC

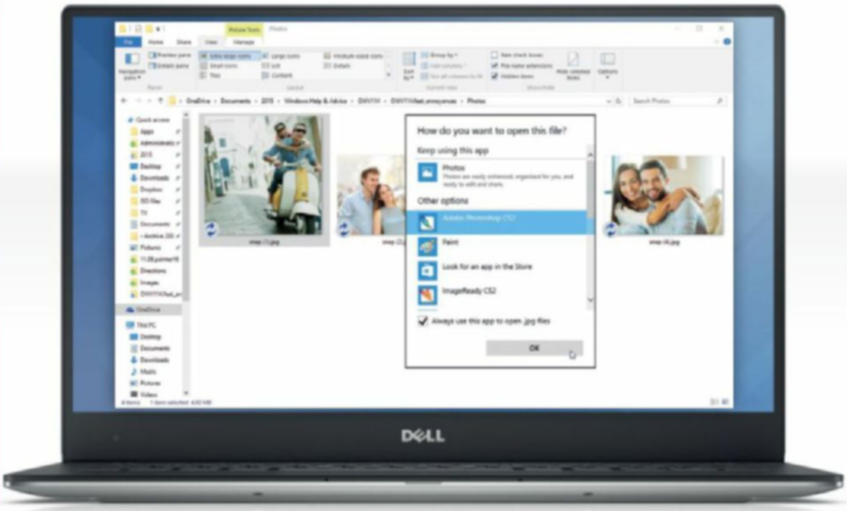
Appearance
☑ Use command bar instead of Ribbon
  ☑ Hide caption text in File Explorer windows
  ☑ Hide caption icon in File Explorer windows
  ☑ Hide Up (go to parent folder) button
  ☑ Enable glass on navigation bar
  ☑ Use alternate navigation buttons style
☑ Show details pane on the bottom

Appearance style: Default style (Windows 7 style / skin style)
Status bar style: Default style (white)
☑ Show status bar

OldNewExplorer 1.1.7

Lose the File Explorer Ribbon

WE'VE LOVED the File Explorer since its introduction in Windows 8, but if you're not a fan of its ribbon interface, you can disable it and restore the Windows 7 look using a program called OldNewExplorer—download it from http://tihiy.net/files/OldNewExplorer.rar. You need a program capable of extracting RAR files to use it—try 7-Zip (www.7-zip.org). Once extracted, launch the program and click "Install," then tick the various boxes to change how File Explorer looks—close and reopen any File Explorer windows to see the effects.

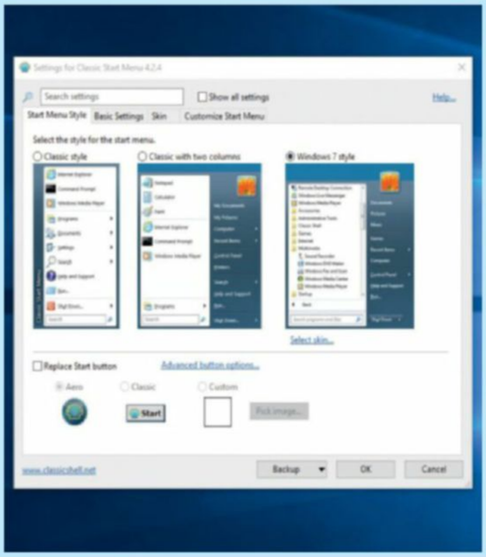

How do you want to open this file?
Keep using this app
Photos
Other options
Adobe Photoshop CS2
Paint
Look for an app in the Store
ImageReady CS2
☑ Always use this app to open .jpg files
OK
DELL

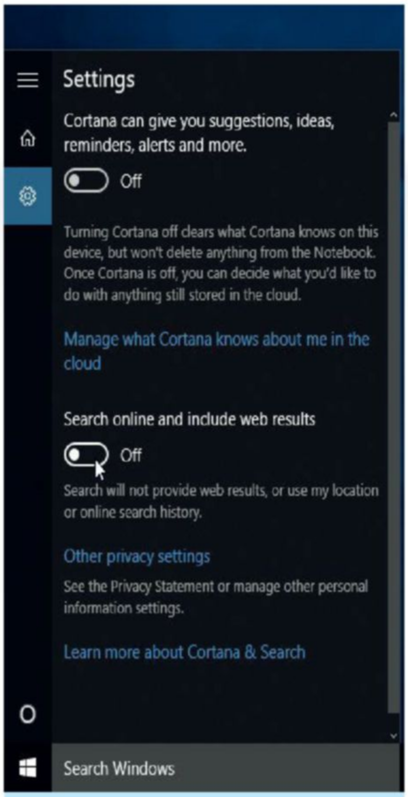
Change Default App by File Type

IF YOUR APP ISN'T LISTED when trying to set it as the default via "Settings," try this instead: Browse to a file you want to open, right-click it, and choose "Open with → Choose another app." Tick "Always open this app…" before selecting your chosen default. If it's not in the list, click "More apps" to reveal more choices, and if your chosen program still isn't there, click "Look for another app on this PC" to manually select it. Start your search under "Program Files" or "Program Files (x86)."

Restore Classic Start Menu

IF YOU'VE UPGRADED FROM WINDOWS 7, you might not like the new "Start" menu at all. If you're hankering after the "classic" style, download and install Classic Shell from www.classicshell.net. During installation, untick all entries except "Classic Start Menu" and "Classic Shell Update." Once it's installed, click the "Start" button to configure it—the default settings should be fine, so click "OK." The classic "Start" menu blends in with the Windows 10 look, but provides settings and shortcuts that you'll be more familiar with—there's even a shortcut to the Windows 10 "Start" menu, too.


Settings for Classic Start Menu 4.2.4
Search settings
☐ Show all settings
Help...
Start Menu Style
Basic Settings
Skin
Customize Start Menu
Select the style for the start menu.
○ Classic style
○ Classic with two columns
● Windows 7 style
Select skin...
☐ Replace Start button
Advanced button options...
● Aero
○ Classic
○ Custom
Start
Pick image...
www.classicshell.net
Backup
OK
Cancel



Settings

Cortana can give you suggestions, ideas, reminders, alerts and more.

Off

Turning Cortana off clears what Cortana knows on this device, but won't delete anything from the Notebook. Once Cortana is off, you can decide what you'd like to do with anything still stored in the cloud.

Manage what Cortana knows about me in the cloud

Search online and include web results

Off

Search will not provide web results, or use my location or online search history.

Other privacy settings

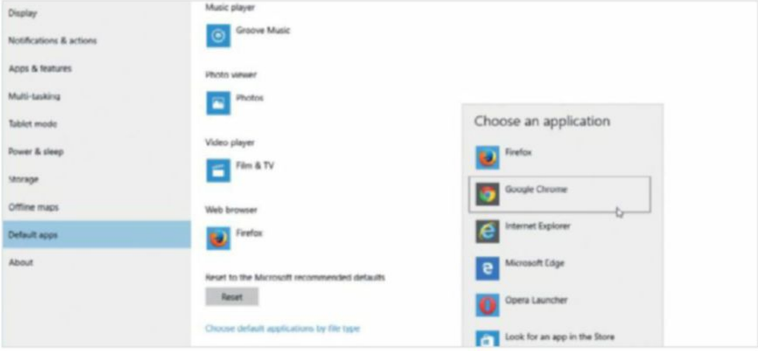
See the Privacy Statement or manage other personal information settings.

Learn more about Cortana & Search

Search Windows

Disable Cortana

THERE'S LITTLE DOUBT that the Windows 10 search bar is useful, but it links into Microsoft Cortana by default. If you decide you don't like Cortana's additional tools, you can reduce its functionality to that of previous versions of Windows. Click the search bar to open Cortana. If you're using it for the first time, click "Not interested" to disable it; otherwise, click the "Settings" button and flick the "Use Cortana" switch to "Off." You can also disable the web portion of Windows 10's search capabilities from here, too, restricting searches to files, programs, and settings on your PC.

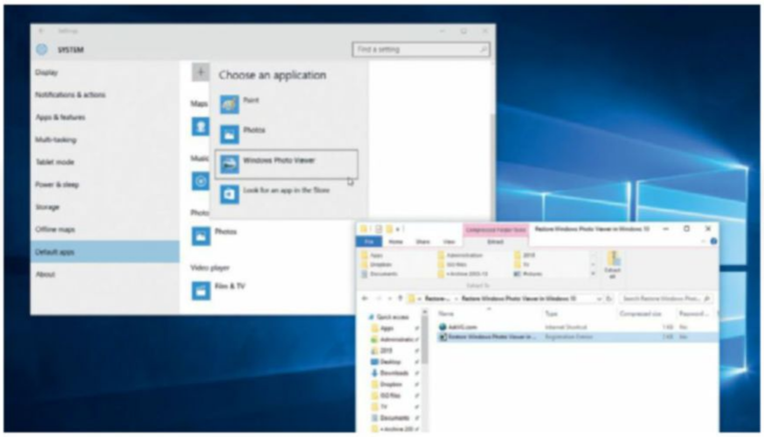

Display
Notifications & actions
Apps & features
Multi-tasking
Tablet mode
Power & sleep
Storage
Offline maps
Default apps
About
Music player
Groove Music
Photo viewer
Photos
Video player
Film & TV
Web browser
Firefox
Reset to the Microsoft recommended defaults
Reset
Choose default applications by file type
Choose an application
Firefox
Google Chrome
Internet Explorer
Microsoft Edge
Opera Launcher
Look for an app in the Store

Change Default Apps in Settings

AFTER UPGRADING TO WINDOWS 10, Microsoft changes your default browser to Edge. To fix this, click "Start → Settings → System → Default apps." Click the Edge entry, then pick your browser from the list that pops up. You can change other key app defaults here: video, photo, mail, and so on. For a wider range of app choices, click "Set defaults by app." Advanced users can also set defaults by file type or protocol using the appropriate links.

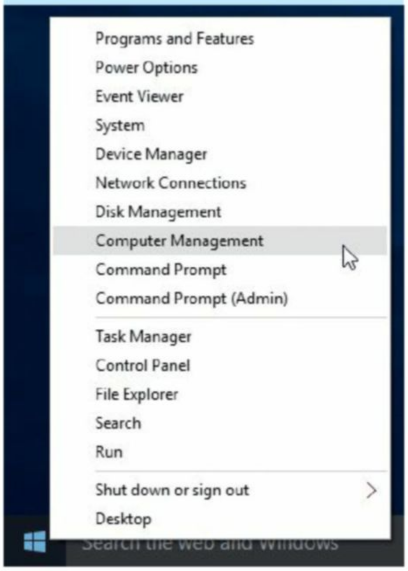
Restore Windows Photo Viewer

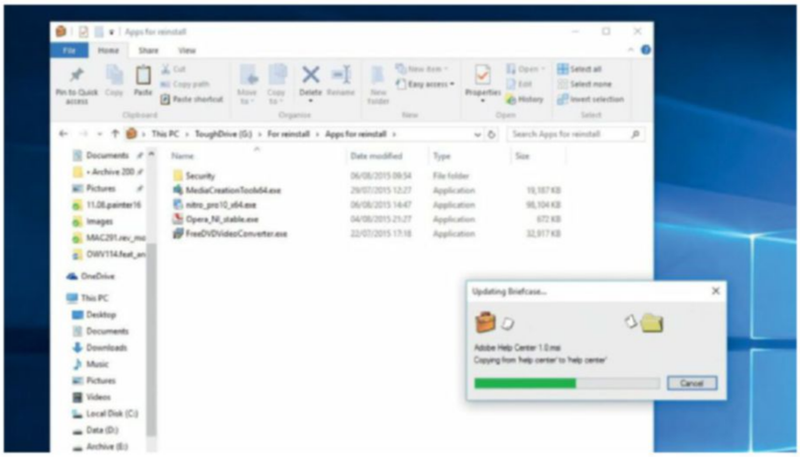
MICROSOFT HAS REPLACED Windows Photo Viewer with the Photos app, but it's possible to restore it as an option when setting the default app for photos. It's a convoluted process—see "Method 4" at www.askvg.com/tip-restoring-windows-photo-viewer-as-default-in-windows-10/. However, the site does provide a ready-made zip file containing the required Registry entries. Download this to your hard drive, then open it to access the .reg file within. Double-click this, then choose "Run" followed by "Yes" (twice) to make Windows Photo Viewer an option once again.


Choose an application
Windows Photo Viewer

Customize Hidden Start Menu

WINDOWS 10 HAS a hidden "Start" menu—press Windows-X or right-click the "Start" button. The menu includes shortcuts to hidden parts of your system, such as the old Control Panel, Run dialog box, and Event Viewer. But you can add your own, or rearrange and delete existing shortcuts with Win+X Menu Editor. Download the zip file from http://winaero.com/download.php?view.21, right-click it, and choose "Extract All" to save it to a suitable folder. Browse to the "x64" (64-bit) or "x86" (32-bit) folder, then double-click "WinXEditor.exe." Click "Add a program" to browse for a program, or "Add preset" for options such as shutdown and restart entries. You can also add individual Control Panel applets and administrative tools.


Programs and Features
Power Options
Event Viewer
System
Device Manager
Network Connections
Disk Management
Computer Management
Command Prompt
Command Prompt (Admin)
Task Manager
Control Panel
File Explorer
Search
Run
Shut down or sign out
Desktop
Search the web and Windows


Updating Briefcase...
Cancel

Restore Briefcase

IT MAY HAVE NICHE APPEAL, but the Briefcase was one of the earliest tools for keeping data synched between two locations. While it's been removed from Windows 10 (and 8), you can get it back again with a Registry tweak. Download the required file from http://winaero.com/blog/wp-content/uploads/2012/09/Briefcase.zip. Double-click it to open it, then double-click "Windows 8-Enable Briefcase.reg." Click "Run," followed by "Yes" twice, then restart Explorer via Task Manager to restore its features. Note: It doesn't work well with User Account Control, so don't create Briefcases inside any administrator-protected folders.

Tighten Privacy in Edge Browser

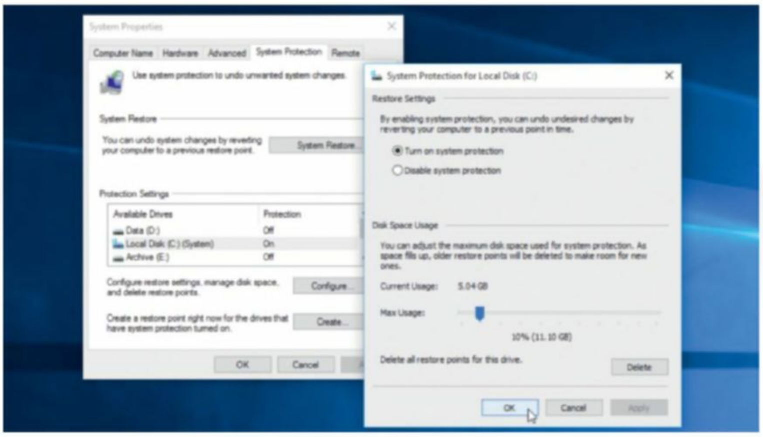
IF YOU STICK with Edge, there are some important privacy settings you need to switch on before relying on it. Launch the browser, then click the "..." button in the top-right corner, and choose "Settings." Scroll down and click "Advanced settings," and make sure the "Block pop-ups" slider is set to "On." While you're there, flick "Send Do Not Track requests" to "On," then set "Cookies" to "Block only third-party cookies" for greater privacy.

Access Classic Display Settings

WE'RE NOT MASSIVE FANS of the new "Personalization" dialog, which is now part of "Settings." If you aren't either, and are hankering after the old "Display Settings" dialog from Windows 7 and 8, you can create a shortcut to it on the desktop. Right-click some blank space, and then choose "New → Shortcut." Now type the following into the "Location" box:
"control.exe desk.cpl,Settings,@Settings"
Click "Next," give the shortcut a suitable name, and click "Finish." Now you can use this freshly created shortcut to tweak your display settings.

Switch System Restore Back On

DON'T ASK US WHY, but on some systems Windows 10 disables System Restore by default. The first thing to do, then, is switch it back on. Press Windows-Pause/Break to open "System Properties," and click "System Protection" in the left-hand column. You should see that "Protection Settings" have been switched off for all your drives. Locate your Windows drive (it should be marked "System"), and click the "Configure..." button. Select "Turn on system protection," and allocate up to 10 percent of your available space using the slider. Click "OK" twice to finish the job.



System Properties

Use system protection to undo unwanted system changes.

System Restore

You can undo system changes by reverting your computer to a previous restore point.

Protection Settings

Available Drives	Protection
Data (D:)	Off
Local Disk (C:) (System)	On
Archive (E:)	Off

Configure restore settings, manage disk space, and delete restore points.

Create a restore point right now for the drives that have system protection turned on.

System Protection for Local Disk (C:)

Restore Settings

By enabling system protection, you can undo undesired changes by reverting your computer to a previous point in time.

● Turn on system protection

○ Disable system protection

Disk Space Usage

You can adjust the maximum disk space used for system protection. As space fills up, older restore points will be deleted to make room for new ones.

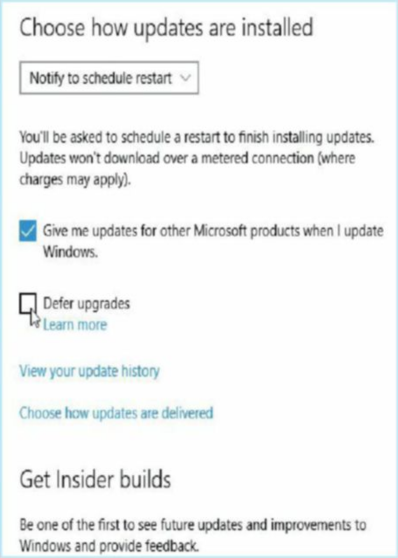
Current Usage: 5.04 GB

Max Usage: 10% (11.10 GB)

Delete all restore points for this drive.

Improve Windows Update

BY DEFAULT, Windows Update now delivers all updates automatically. While you can't put them off indefinitely, you can improve matters. Go to "Settings → Update & Security → Windows Update → Advanced Options." Windows 10 Pro users can select "Defer upgrades" to put off non-security updates for several months. Windows 10 Home users, on the other hand, should set "Choose how updates are installed" to "Notify to schedule restart," so they can receive alerts that updates are about to be installed. Home users with Wi-Fi connections can also postpone updates by going to "Settings → Network & Internet → WiFi → Advanced Options," and flicking the "Metered Connection" switch to "On" until you are ready to update.



Choose how updates are installed

Notify to schedule restart

You'll be asked to schedule a restart to finish installing updates. Updates won't download over a metered connection (where charges may apply).

☑ Give me updates for other Microsoft products when I update Windows.

☐ Defer upgrades

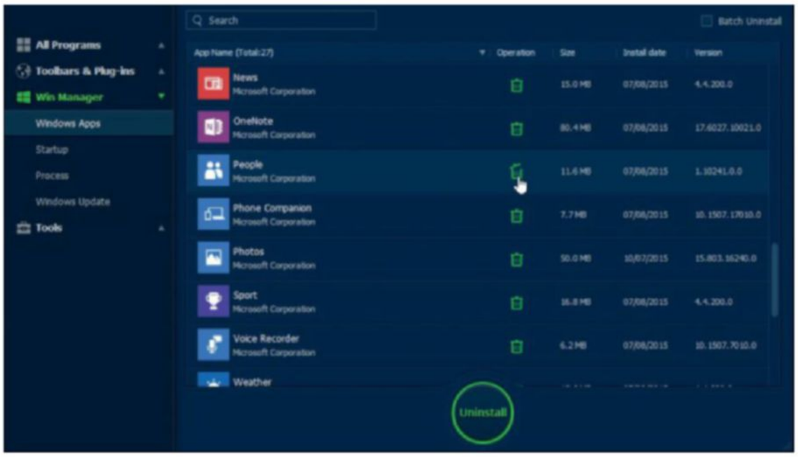
Learn more

View your update history

Choose how updates are delivered

Get Insider builds

Be one of the first to see future updates and improvements to Windows and provide feedback.



App Name (Total:27)	Operation	Size	Install date	Version
News Microsoft Corporation	🗑	15.0 MB	07/08/2015	4.4.200.0
OneNote Microsoft Corporation	🗑	80.4 MB	07/08/2015	17.6027.10021.0
People Microsoft Corporation	🗑	11.6 MB	07/08/2015	1.10241.0.0
Phone Companion Microsoft Corporation	🗑	7.7 MB	07/08/2015	10.1507.17010.0
Photos Microsoft Corporation	🗑	50.0 MB	10/07/2015	15.803.16240.0
Sport Microsoft Corporation	🗑	16.8 MB	07/08/2015	4.4.200.0
Voice Recorder Microsoft Corporation	🗑	6.2 MB	07/08/2015	10.1507.7010.0
Weather				

Remove Unwanted Apps

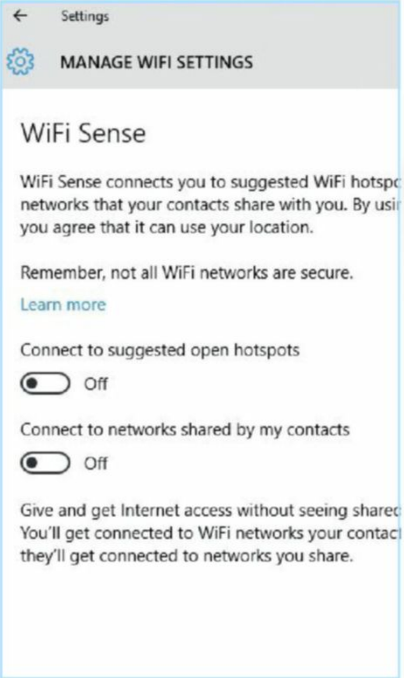
WINDOWS 10 SHIPS with a number of built-in apps, such as Mail, Money, and Groove Music. However, if you don't like any of these, Microsoft doesn't provide an "Uninstall" option to help you get rid of them. You can still ditch them, though, with IOBit Uninstaller 5 (www.iobit.com/advanceduninstaller.php). Once installed, open the app from the "Start → All apps" menu, then select "Win Manager" from the left-hand menu, and select "Windows Apps." Expand the "Windows Apps" section, where you'll see all the apps listed. Click the dustbin next to one to remove it. Any apps can be restored later through the Store.

Tame Quick Access

QUICK ACCESS can be a mess, mixing pinned icons, frequently accessed folders, and recent items. Open File Explorer, switch to "View," and click "Options." Disable the latter two via "Privacy," and instruct File Explorer to open to the "This PC" view instead of "Quick Access." You can pin the "Recent Places" shortcut to "Quick Access"—press Windows-R, type **%AppData%\Microsoft\Windows\** and press Enter. Right-click the "Recent Items" shortcut, and choose "Pin to Quick Access."

Restore Classic Alt-Tab Switcher

PRESS ALT-TAB, and Windows 10 displays a list of thumbnails for all of your open windows. If you would rather stick with the old look, press Windows-R, and type "regedit" to open Registry Editor. Browse to the following key: "HKEY_CURRENT_USER\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer." Now select "Edit → New → DWORD (32-bit) Value." Name it "AltTabSettings." Double-click the value and set it to 1. Now restart Explorer from Task Manager to restore the icon task switcher.



WiFi Sense

WiFi Sense connects you to suggested WiFi hotsp
networks that your contacts share with you. By usi
you agree that it can use your location.

Remember, not all WiFi networks are secure.

Learn more

Connect to suggested open hotspots

○ Off

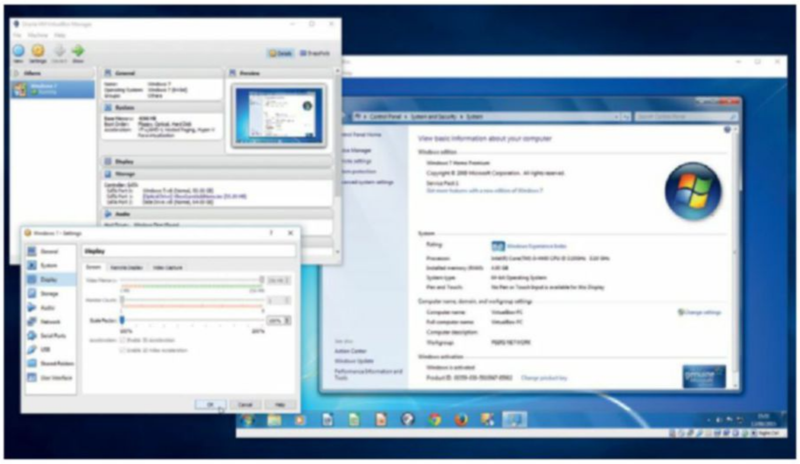
Connect to networks shared by my contacts

○ Off

Give and get Internet access without seeing share
You'll get connected to WiFi networks your contac
they'll get connected to networks you share.

Disable Wi-Fi Sense

IF YOU CONNECT wirelessly to your network, the Wi-Fi Sense feature, which connects you to crowdsourced Wi-Fi hotspots and networks shared by your contacts, is enabled by default if you choose "Express Settings" during the Windows 10 upgrade process. It's designed to make it easier to connect to friends' networks through your Facebook, Outlook.com, or Skype contacts list. If you'd rather not share this information, you can disable it. Click "Start → Settings → Network & Internet → WiFi." Click "Manage WiFi Settings," and flick both switches to "Off" to prevent your network details being shared with others.



Run Older Apps

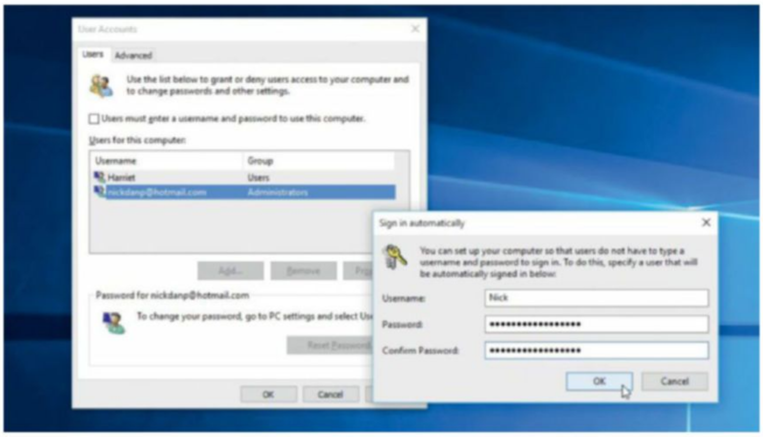
MOST APPS that work in Windows 7 and 8 should also work in Windows 10, but if your app doesn't work, all may not be lost. If you still have access to a non-OEM copy of an older version of Windows, you can install it in a virtual machine, courtesy of VirtualBox (www.virtualbox.org). Basically, this enables you to create a virtual PC inside Windows 10, into which you can install your old programs while you look for a compatible update or suitable alternative.

Recover Hard Drive Space

ONCE YOU'RE UP and running with Windows 10, and convinced you won't need to go back to your previous version of Windows, it's time to free up some drive space. Open File Explorer, go to "This PC," right-click your "C" drive, choose "Properties," then click "Disk Clean-up." As soon as the dialog opens, click "Clean up system files," and wait for it to scan again. Go through the list, ticking those items you don't need—the biggest item by far will be "Previous Windows installation(s)." Tick this to free up space, but remember there's no going back once the files are gone.

OneDrive Changes

ONE OF THE BEST features of OneDrive in Windows 8 was the ability to use "placeholders" for certain folders, effectively giving you access to your stored files without having to also hold a copy on your hard drive. Sadly, Windows 10 ditches this feature (for now). Instead, you need to specify which folders you want to keep synched on your PC. To do this, right-click the OneDrive icon in the Taskbar Notification area, and select "Settings." Switch to the "Choose Folders" tab, and click "Choose Folders." Untick "Sync all files and folders on my OneDrive," and then tick only those folders you need access to.



Use the list below to grant or deny users access to your computer and to change passwords and other settings.

☐ Users must enter a username and password to use this computer.

Users for this computer:

Username	Group
Harriet	Users
nickdanp@hotmail.com	Administrators

Password for nickdanp@hotmail.com

To change your password, go to PC settings and select Us

You can set up your computer so that users do not have to type a username and password to sign in. To do this, specify a user that will be automatically signed in below:

Username: Nick

Password: ••••••••••••••••••

Confirm Password: ••••••••••••••••••

Bypass Login

IF YOU'RE THE ONLY USER of your PC, and you'd like to boot straight to the desktop without having to enter your password, here's what to do. Press Windows-R to open the "Run" dialog, then type "netplwiz," and press Enter. Make sure your user account is selected, then untick "Users must enter a username and password to use this computer," and click "Apply." Enter your user password and click "OK" twice. Windows will also require you to enter your password after your PC wakes from sleep. If security isn't an issue, click "Start → Settings → Accounts → Sign-in options," and change the "Require sign-in" drop-down to "Never." ⏻

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TRION WORLDS XLGAMES MAXIMUMPC KICK ASS! PC GAMER EDITOR'S CHOICE ★★★★★

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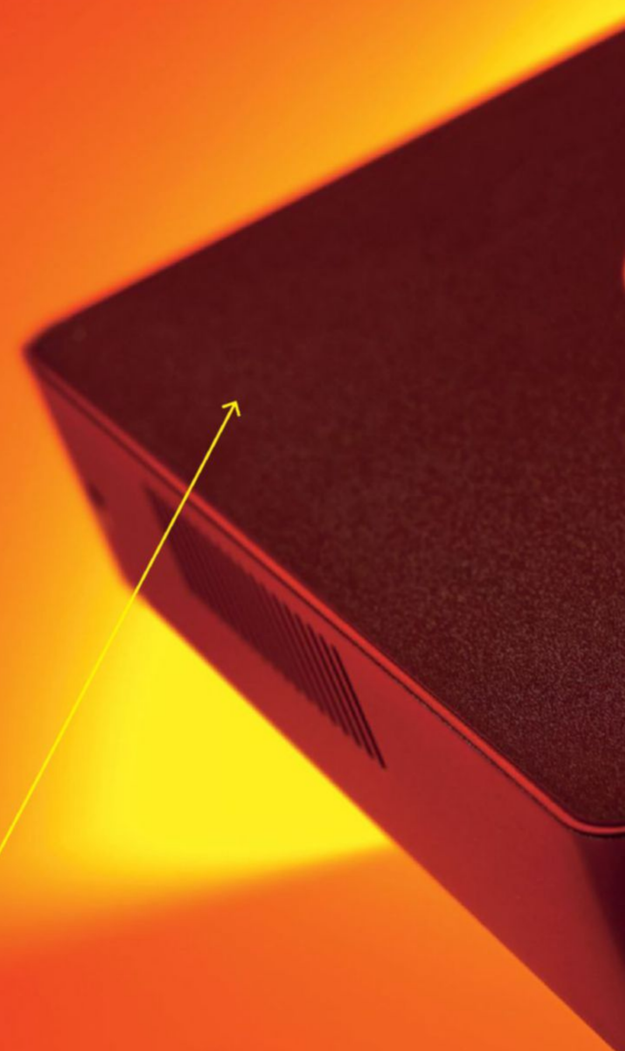
TECH PORN

Zotac ZBOX Magnus EN970

OK, WE ALL KNOW that SteamOS has been a colossal failure so far. Unsurprisingly, Linux simply cannot compete with Windows when it comes to the fiery crucible that is frame rendering combat. However, that shouldn't put you off small-form-factor living-room gaming. No, sir, not by a long shot.

Fortunately, Valve did innovate in one vital area: Big Picture Mode. Couple that with a capable mini PC from Zotac, and we're on to a winner. The true beauty of Zotac's Magnus resides at its heart. Beating silently and confidently for all of your computational needs is a beautifully power-efficient Intel Core i5-5200U. And what's the perfect match for that? Well, how about a full-fledged Nvidia GeForce GTX 960? Couple that with up to 16GB of DDR3, one M.2 SSD, and two 2.5-inch hard drives, and you're set for one perfectly beautiful 1080p gaming experience. –**ZAK STOREY**



1 It's a beauty

Zotac has managed to develop a stunningly simple yet elegant case, with enough room inside to ensure you have all the necessary components available for a truly 1080p-ready gaming experience. Move aside consoles, you've got nothing on the Magnus.

USB3.0
ZOTAC
PWR
WIFI
HDD

2 Full GTX 960

Interestingly, the GPU inside the Magnus EN970 is a full Nvidia GeForce GTX 960, and not the mobile edition. Although you're not going to be overclocking this puny thing any time soon, it should provide more than enough frames for casual gaming in your living room.

3 Alternatively...

Still hooked on the idea of a Steam Machine for your living room? Don't care about the performance hit? Well, you could opt for Zotac's NEN Steam Machine, the SN970. It's identical in almost every way, bar the slight upgrade to a Skylake CPU.

MAXIMUMPC
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MAXIMUM PC'S 14TH IRREGULAR GEEK QUIZ

SHARPEN YOUR PENCILS, IT'S TIME TO GET YOUR GEEK ON

BY ALAN DEXTER

Do you buy *Maximum PC* for the pretty pictures (and they are very pretty), or do you actually absorb all the information that we present each month? It's time to find out whether you've been paying attention, or just buying this fine, fine magazine simply to look cool. That's right, it's that time again when we stress your brain with a series of hardfire questions that will separate the X-Men from the Boy Wonders.

Obviously, you could sit there with Google as your trusty ally, but we already know what score you'll get if you do that. Instead, we ask you to be honest with yourself, and see how you cope with the gauntlet of tough questions laid out before you. In return, we won't judge you if you get them all wrong—though statistically that's quite unlikely.

Oculus Rift and VR

1 Who was the original founder of Oculus VR and inventor of Oculus Rift?

A) ☐ Brendan Iribe
B) ☐ Michael Antonov
C) ☐ Palmer Luckey
D) ☐ Michael Abrash

2 Prior to Facebook's buyout, how much money did Oculus VR raise in total?

A) ☐ $2.4 million
B) ☐ $91 million
C) ☐ $9.78 million
D) ☐ $75 million

3 What is the screen resolution of the consumer version of Oculus Rift?

A) ☐ 3840x2160
B) ☐ 2160x1200
C) ☐ 1920x1080
D) ☐ 1280x720

4 Oculus is funding several games to be developed exclusively for the Rift, including which of these?

A) ☐ Dirt Rally
B) ☐ Eve Valkyrie
C) ☐ Edge of Nowhere
D) ☐ Heavy Gear Assault

5 What is the name of the tracking system used by the HTC Vive?

A) ☐ Constellation
B) ☐ Galaxy
C) ☐ Tsunami
D) ☐ Lighthouse

SSDs, Compact Flash, and Storage

6 **Samsung was the first to market with a 2TB consumer SSD, but what warranty does it offer with the 2TB 850 Pro?**

A) ☐ Three years
B) ☐ Five years or 75TBW (terrabytes written)
C) ☐ 10 years or 300TBW (terrabytes written)
D) ☐ Lifetime

7 **What is the theoretical maximum throughput for an M.2 SSD attached to a PCI-E 3.0 x4 interface?**

A) ☐ 550MB/s
B) ☐ 750MB/s
C) ☐ 2GB/s
D) ☐ 4GB/s

8 **According to industry analyst IHS, how much revenue will SSDs generate in 2016?**

A) ☐ $14.1 billion
B) ☐ $13.2 billion
C) ☐ $227 million
D) ☐ $27.3 billion

9 **What was the first version of Windows to offer TRIM support?**

A) ☐ Windows 8.1
B) ☐ Windows 8
C) ☐ Windows 7
D) ☐ Windows Vista

10 **According to Intel, how much faster than NAND is its new 3D XPoint technology?**

A) ☐ 10x
B) ☐ 100x
C) ☐ 1,000x
D) ☐ 15,000x

SAMSUNG
Solid State Drive

Graphics Cards and GPUs

11 **What is the TDP of Nvidia's GeForce GTX 980 Ti?**

A) ☐ 250W
B) ☐ 210W
C) ☐ 165W
D) ☐ 145W

12 **What is the name of the low-level, cross-platform 3D graphics and compute API that has been referred to as the "next-generation OpenGL initiative"?**

A) ☐ GNM
B) ☐ Mantle
C) ☐ Vulkan
D) ☐ Khronos

13 **What is the codename for AMD's flagship GPU, the Radeon R9 Fury X?**

A) ☐ Fiji PRO
B) ☐ Fiji XT
C) ☐ Hawaii XT
D) ☐ Antigua PRO

14 **How big is the die used by the GeForce GTX Titan X?**

A) ☐ 148mm^2
B) ☐ 227mm^2
C) ☐ 398mm^2
D) ☐ 601mm^2

15 **What is the official core clock speed of the R9 Nano?**

A) ☐ 900MHz
B) ☐ Up to 1,000MHz
C) ☐ 1,050MHz
D) ☐ 1,100MHz

SAPPHIRE
NITRO
NITRO
NITRO
DP
HDMI
DP
DVI

Graphics Cards and GPUs Continued

16 **How wide is the memory bus on the GeForce GTX 980?**

A) ☐ 512-bit
B) ☐ 384-bit
C) ☐ 256-bit
D) ☐ 128-bit

17 **Nvidia's GM206 supports full fixed function HEVC hardware decoding, but what's the maximum resolution supported by the standard?**

A) ☐ 8192x4320
B) ☐ 7680x4320
C) ☐ 4096x2160
D) ☐ 3840x2160

18 **Which one of these GPUs has the most transistors?**

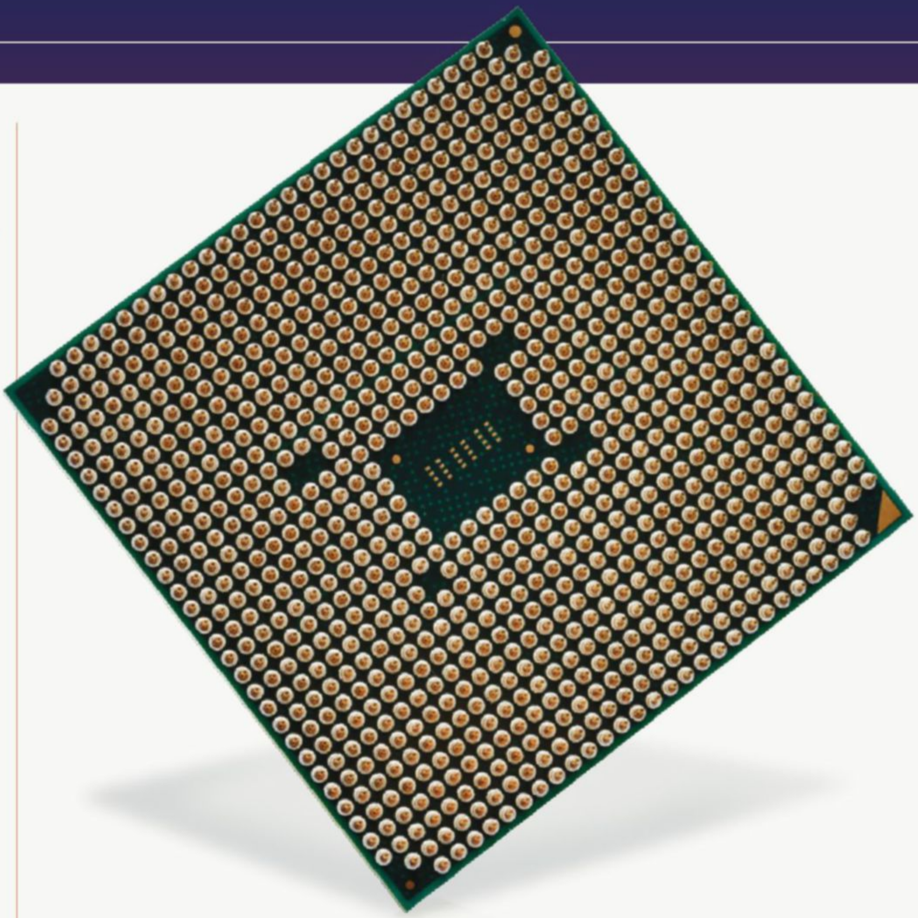
A) ☐ GeForce GTX Titan X
B) ☐ Radeon R9 Fury
C) ☐ Radeon R9 390X
D) ☐ GeForce GTX Titan Black

19 **Next-gen microarchitecture, Nvidia's Pascal, boasts a new high-speed bus called NVLink. How fast is it?**

A) ☐ 8GB/s
B) ☐ 32GB/s
C) ☐ 128GB/s
D) ☐ 200GB/s

20 **Which of these is *not* a codename used by AMD for its next-gen Arctic Islands GPUs?**

A) ☐ Greenland
B) ☐ Ellesmere
C) ☐ Monumental
D) ☐ Baffin



CPUs, APUs, and SoCs

21 **How many execution units are there in the HD 530 graphics subsystem found in Intel's Core i7-6700K Skylake CPU?**

A) ☐ 12
B) ☐ 24
C) ☐ 48
D) ☐ 72

22 **How much L3 cache will you find in the Core i7-6700 and Core i7-6700K?**

A) ☐ 8MB
B) ☐ 6MB
C) ☐ 4MB
D) ☐ 3MB

23 **Which of these mobile Skylake processors features Intel's Iris 550 graphics core?**

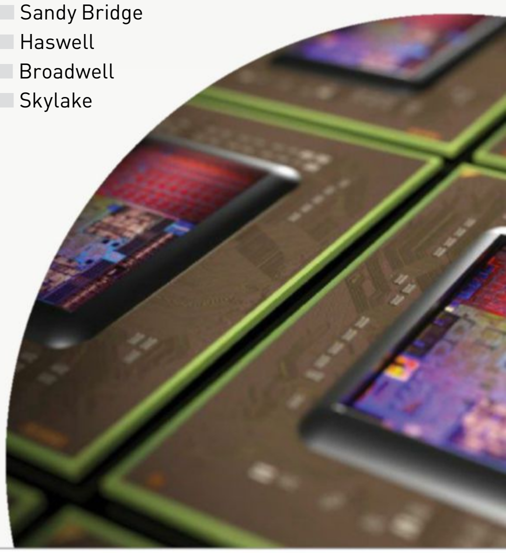
A) ☐ Core i7-6920HQ
B) ☐ Core i5-6300U
C) ☐ Core i3-6167U
D) ☐ Pentium 4405Y

24 **Which of these has Intel *not* used as a codename for a processor?**

A) ☐ Conroe
B) ☐ Nehalem
C) ☐ Haswell
D) ☐ Langwell

25 **Only one of the following microarchitectures is designated as a "tick" under Intel's "tick-tock" naming model—which one is it?**

A) ☐ Sandy Bridge
B) ☐ Haswell
C) ☐ Broadwell
D) ☐ Skylake



26 **Which of these chips has the fastest core clock speed (excluding turbo)?**

A) ☐ Core i7-6700
B) ☐ Core i5-6600
C) ☐ Core i3-6300
D) ☐ Pentium G4520

27 **In terms of processor specifications, what does TDP stand for?**

A) ☐ Total Design Power
B) ☐ Thermal Design Power
C) ☐ Throttled Design Point
D) ☐ Thermal Danger Point

28 **What is the core clock speed of AMD's top-end A10-7870K?**

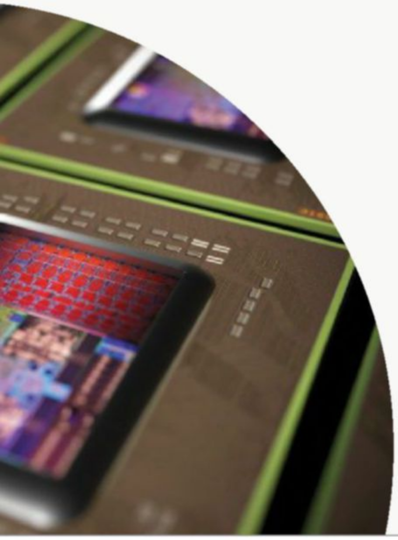
A) ☐ 3.5GHz
B) ☐ 3.7GHz
C) ☐ 3.9GHz
D) ☐ 4.1GHz

29 **AMD's Kaveri microarchitecture includes a dual-channel memory controller, but what is the fastest memory type supported by A10 chips?**

A) ☐ DDR3-1333
B) ☐ DDR3-1600
C) ☐ DDR3-1866
D) ☐ DDR3-2133

30 **What manufacturing process will AMD's next-gen "Zen" microarchitecture use?**

A) ☐ 14nm
B) ☐ 16nm
C) ☐ 22nm
D) ☐ 28nm



Windows and Operating Systems

31 **What was the official release date of Windows 10?**

A) ☐ July 15
B) ☐ July 29
C) ☐ August 1
D) ☐ September 1

32 **When does extended support for Windows 7 end?**

A) ☐ January 14, 2020
B) ☐ July 22, 2019
C) ☐ January 13, 2018
D) ☐ February 22, 2017

33 **What was the codename for Windows 10?**

A) ☐ Redstone
B) ☐ Threshold
C) ☐ Blue
D) ☐ Blackcomb

34 **What is the minimum supported display resolution for running Windows 10?**

A) ☐ 640x480
B) ☐ 800x600
C) ☐ 1024x768
D) ☐ 1280x1080

35 **Windows 10 uses the WDDM graphics architecture, but what does WDDM stand for?**

A) ☐ Widescreen Driver Display Mechanism
B) ☐ Windows Digital Display Model
C) ☐ Windows Device Driver Model
D) ☐ Windows Display Driver Model

36 **What was the first Microsoft OS to natively support USB 3.0?**

A) ☐ Windows 7
B) ☐ Windows 8
C) ☐ Windows 8.1
D) ☐ Windows 10

Windows and Operating Systems Continued

37 The first major upgrade to Windows 10 was released at the end of 2015, but what was the official name of the patch?

A) ☐ TH2
B) ☐ Build 10586
C) ☐ November Update
D) ☐ Creeper

38 The first big patch for Windows 10 included plenty of fixes, but which of the following was *not* in the patch?

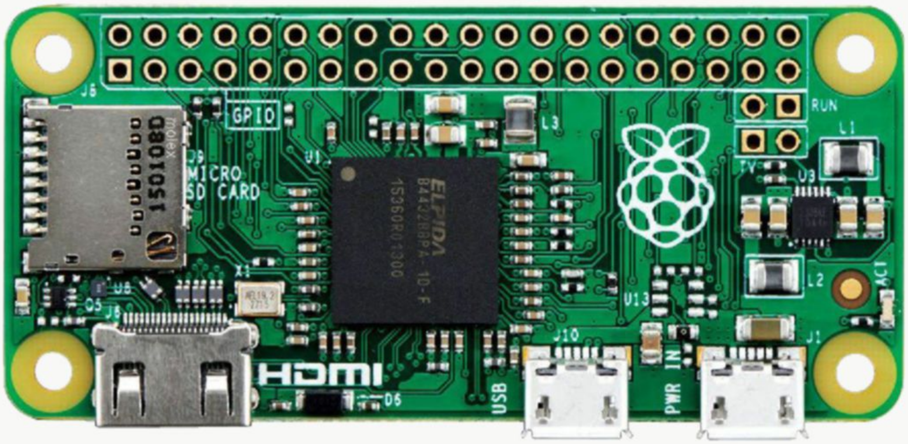
A) ☐ Introduced colored title bars
B) ☐ Browser synching support for the Edge browser
C) ☐ Native support for HoloLens
D) ☐ Integrated Skype

39 Before release, Windows 10 Mobile boasted support for iOS and Android apps via its Windows Bridge tools, but what's the codename of the Android bridge?

A) ☐ Islandwood
B) ☐ Astoria
C) ☐ Continuum
D) ☐ Luminescence

40 Who is the voice actress behind Cortana's insightful tones?

A) ☐ Kelly Hu
B) ☐ Kristen Bell
C) ☐ Jen Taylor
D) ☐ Mila Kunis



Screens, Interfaces, and General Technology

41 What's the maximum theoretical bandwidth for Thunderbolt 3?

A) ☐ 1.25GB/s
B) ☐ 2GB/s
C) ☐ 4GB/s
D) ☐ 5GB/s

42 What does MQA stand for when it comes to audio?

A) ☐ Meridian Quantization Algorithm
B) ☐ Master Quality Authenticated
C) ☐ Music Quality Audio
D) ☐ Modulated Quantization Analog

43 Which standard was the first to support the 4K resolution at 60Hz?

A) ☐ HDMI 1.1
B) ☐ HDMI 1.4
C) ☐ HDMI 1.4a
D) ☐ HDMI 2.0

44 How many pixels are there on a standard UHD display?

A) ☐ 8,631,360
B) ☐ 7,028,736
C) ☐ 8,847,360
D) ☐ 8,294,400

45 Which manufacturer was the first to release a TV that featured quantum dot display technology?

A) ☐ Sony
B) ☐ Sharp
C) ☐ Samsung
D) ☐ Seiki

46 Where does the key combination Win-Pause/Break take you in Windows 10?

A) ☐ Device Manager
B) ☐ System
C) ☐ Control Panel
D) ☐ Task Manager

47 A new, tiny, $5 version of the Raspberry Pi was born at the end of 2015. What was it called?

A) ☐ Raspberry Pi 3
B) ☐ Raspberry Pi 2 Model C+
C) ☐ Raspberry Pi Zero
D) ☐ Raspberry Pi Model A+

48 **Bitcoin struggled through most of 2015, but how low did the value drop?**

A) ☐ $70
B) ☐ $178
C) ☐ $213
D) ☐ $463

49 **Which of these sites was *not* the victim of a major hack or breach in 2015?**

A) ☐ VTech
B) ☐ Ashley Madison
C) ☐ Anthem
D) ☐ Kickstarter

50 **What score did our Dream Machine 2015 manage in 3DMark Firestrike?**

A) ☐ 8,016
B) ☐ 8,378
C) ☐ 15,493
D) ☐ 16,384

GEEK POINT AVERAGE

Time's up, pencils down—it's that moment when you emerge from the battle of the brain and survey the damage

0–12 CORRECT: SUNNYDALE HIGH DROP-OUT

Your results strongly resemble a smoking crater. Are you sure you've come to the right magazine? There, there, everything will be better soon. You should regain the use of your limbs and higher brain function in a few days.

13–24 CORRECT: MOS EISLEY COMMUNITY COLLEGE

You managed to avoid disaster, but our investigators have yet to determine how much of that was due to pure luck. You probably got a decent number of these correct on purpose, for which we had a commemorative pin, until the budget cuts.

25–37 CORRECT: CAL STATE HOGWARTS

We would find you tolerable in a party setting. You probably know a respectable number of *Matrix* and *Star Wars* references, and you can argue both sides of the robot slave labor debate. But you're not quite ready to take the red pill.

38–50 CORRECT: VULCAN INSTITUTE OF TECHNOLOGY

You completed the Kessel Run in 10 parsecs (and you can argue why the use of "parsecs" is both right and wrong). Your knowledge is indisputably vast and mysterious, like an oil tanker that runs on neutrinos. We hope you are using your powers for good, and we tip our fedora to you.

ANSWERS

Oculus Rift and VR: 1)**C**, 2)**B**, 3)**B**, 4)**C**, 5)**D**. *SSDs, Compact Flash and Storage:* 6)**C**, 7)**D**, 8)**A**, 9)**C**, 10)**C**. *Graphics Cards and GPUs:* 11)**A**, 12)**C**, 13)**B**, 14)**D**, 15)**B**, 16)**C**, 17)**A**, 18)**B**, 19)**D**, 20)**C**. *CPUs, APUs and SoC:* 21)**B**, 22)**A**, 23)**C**, 24)**D**, 25)**C**, 26)**C**, 27)**B**, 28)**C**, 29)**D**, 30)**A**. *Windows and Operating Systems:* 31)**B**, 32)**A**, 33)**B**, 34)**B**, 35)**D**, 36)**B**, **37**)C, **38**)C, **39**)B, **40**)C. *Screens, Interfaces and General Technology:* 41)**D**, 42)**B**, 43)**D**, 44)**D**, 45)**A**, 46)**B**, 47)**C**, 48)**B**, 49)**D**, 50)**C**.

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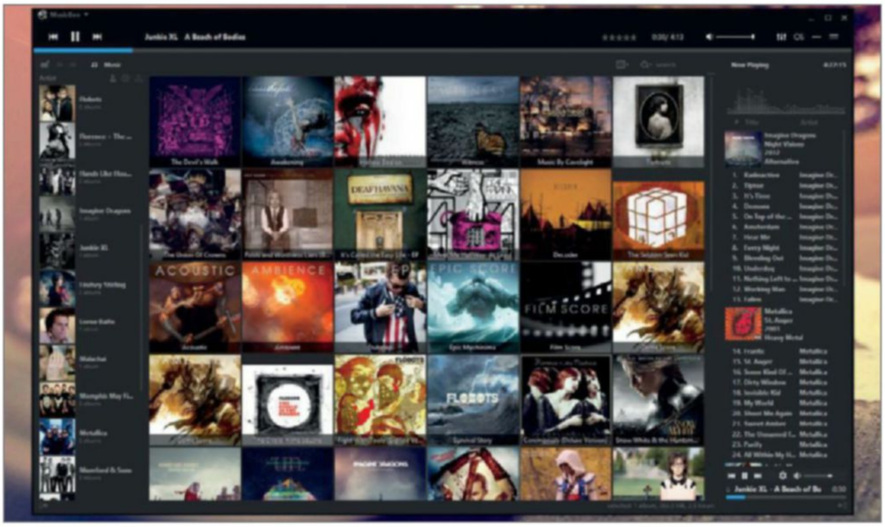
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

WINDOWS TIP OF THE MONTH



REPLACE ITUNES WITH AN APP THAT WORKS

Loathe iTunes? Dislike its enormous install size, cumbersome Windows experience, and limited customization? Don't worry—we've scoured the Internet for the perfect solution. Enter MusicBee, a beautiful piece of open-source freeware developed by the community and founded by Steven Mayall. At only 15MB, it's fully customizable, easy to configure, and comes with a phenomenal range of plugins. www.getmusicbee.com

MAKE – USE – CREATE

62
Play Retro Games on Your Raspberry Pi

68
Retouch Skin in Adobe Photoshop

70
Build a Home-Brewed Steam Machine

ZAK STOREY
STAFF WRITER

CPU QUERIES

I want to talk to you about processors. It's something of a sticky subject for me. I love overclocking, I love CPUs, and I love watching those benchmark figures climb higher. Hell, even seeing those 12 little squares rendering that bland image in Cinebench R15 makes me happy. So what's the problem at the moment, then? Well, I'm currently planning my next build. Just before I joined the *Maximum PC* team, I gave my previous rig away to a good friend of mine. In short, I couldn't keep it at my old man's house, and I couldn't haul it all the way over to my new place either, so I figured that he could make more use out of it.

And because of that, it's put me in an interesting position. I have to be careful about what decision I take next. Which CPU I should purchase. I would absolutely adore to have an Intel Core i7-5930K. It's the dream CPU, as far as I'm concerned. Not ridiculously over the top on price or core count, yet it harbors enough PCIe lanes to sate my desire for a two-way SLI/Xfire setup, and an M.2 PCIe drive. Question is, do I really need it? And the answer? Probably not. I just can't warrant it. I don't stream, I don't render videos, and I don't do any 3D modeling, so the extra cores and Hyper-Threading just don't make sense for me. I'd be far better off investing in an Intel Core i5-6600K, certainly as far as gaming goes. It's important that we head back to that old Intel adage: If you don't profit from Hyper-Threading and more cores, it's just not worth it.

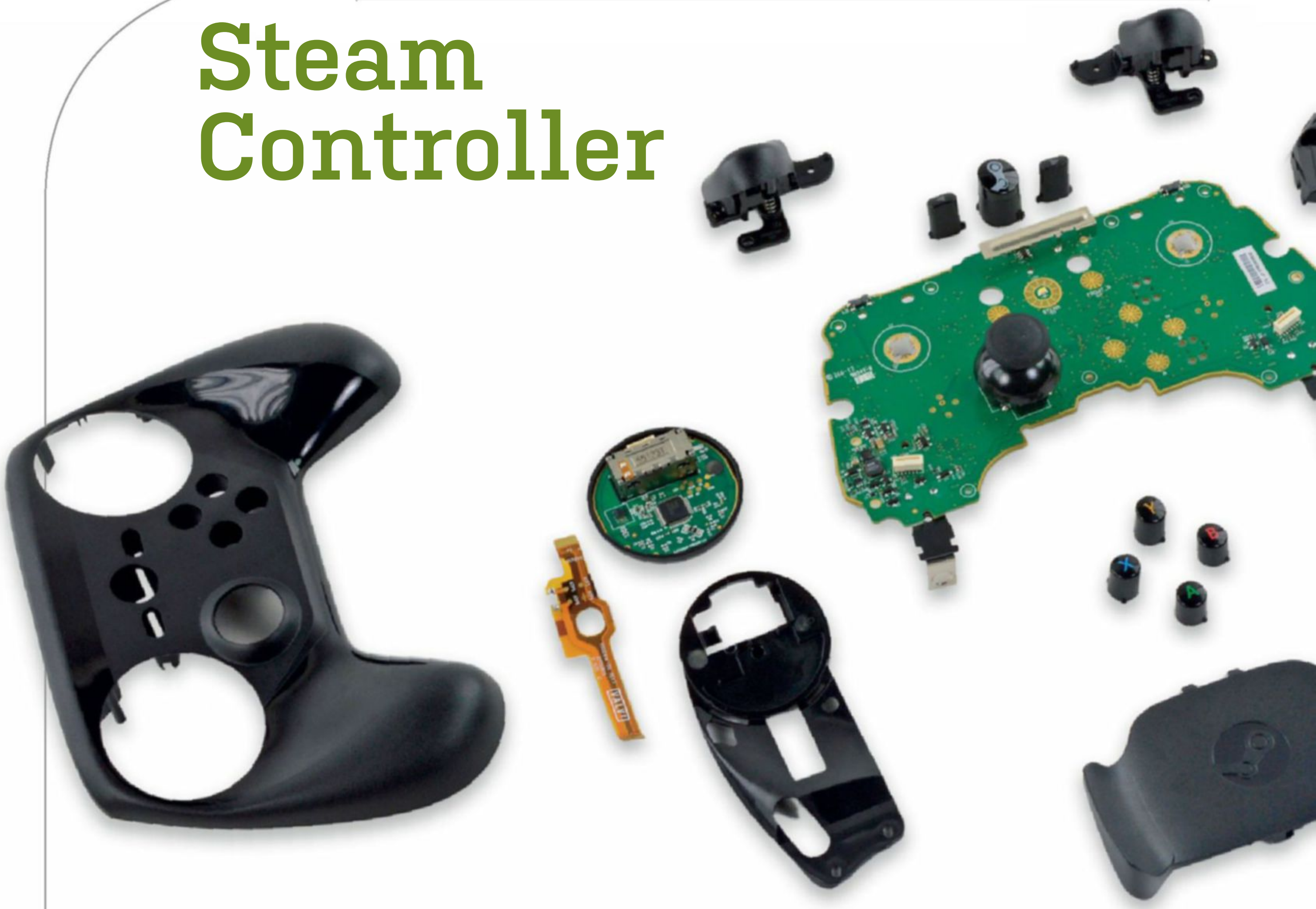
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

Steam Controller

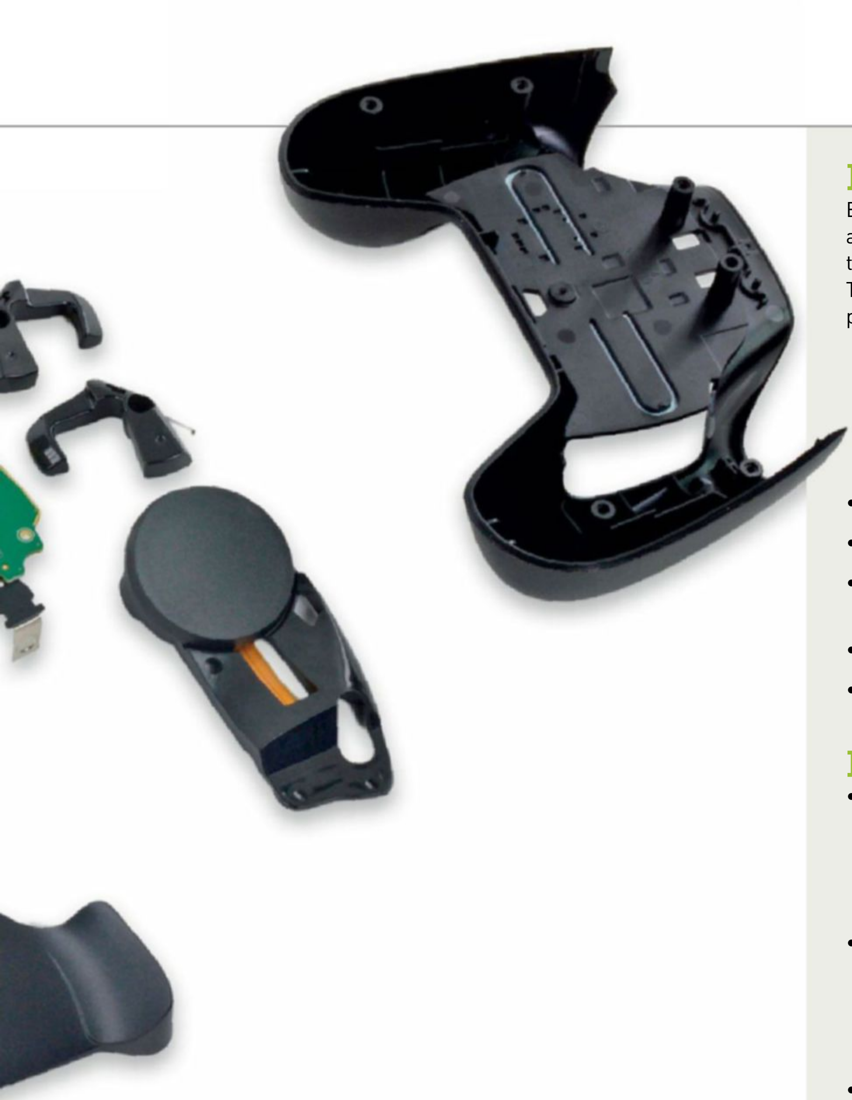


Don't take this simple design for granted—if anything, it makes it easier to fix.

Even the ribbons have “Valve” written on them.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.



BACKGROUND:

Every once in a while, cloud software giant Valve tries its hand at hardware—see the Steam Machine. This time, it's promised to revolutionize the way we game with its Steam Controller. The company has impressed us with highly modular tech in the past, so let's find out how much game this controller has.

MAJOR TECH SPECS:

- High-definition haptic feedback
- Dual trackpads
- USB 2.0 via micro-USB port
- Six-axis combination gyroscope-accelerometer sensor
- Dual-stage digital triggers with 10° of travel, magnetic flux sensor, and tactile switch
- Up to 80 hours of gameplay from two removable AA batteries
- Five meters of wireless communication range

KEY FINDINGS:

- The rear cover snaps off with no tools required to reveal the model number: 1001. After rooting around the battery compartment, we punch through the sticker on the back to find three T6 Torx screws. With the rear housing removed, we get our first look inside.
- Underneath the rear casing, we find a couple of battery eject levers. Faster battery replacements mean less time not playing games. While battery eject levers are nice, what we're actually interested in is Valve's decision to abstain from using an integrated battery.
- It's a trap! Lifting the motherboard out of its housing reveals a couple of hidden ribbon cables connecting the touchpads to the underside of the board. Removing the mobo without dispatching these cables will increase your repair woes.
- We use a plastic opening tool from our new Pro Tech Toolkit to bust the touchpad out from its bracket bars. The ribbon cable plugs into a socket on the touchpad daughterboard and is soldered to the haptic feedback actuators. The brains of the operation is a Cirque 1CA027 companion MCU.
- The dual-stage trigger can be broken down into two stages: The first is the smooth motion of the trigger when pressed. The magnetic flux sensor measures the position and speed of the trigger based on a time-varying flux. The second part is the click when the trigger presses a button on the mobo.
- Repairability Score: 8 out of 10 (10 is easiest to repair). The only adhesive we encountered was on the touchpads. All other mechanical connections are made with screws. The Controller's modular construction means replacing a single component is a simple task. While we always say screws before glue, the non-magnetic screws here are apt to get misplaced. The most likely-to-fail component, the thumbstick, is soldered directly to the motherboard.

Dual motion triggers—ooh, fancy!

Play Retro Games on Your Raspberry Pi

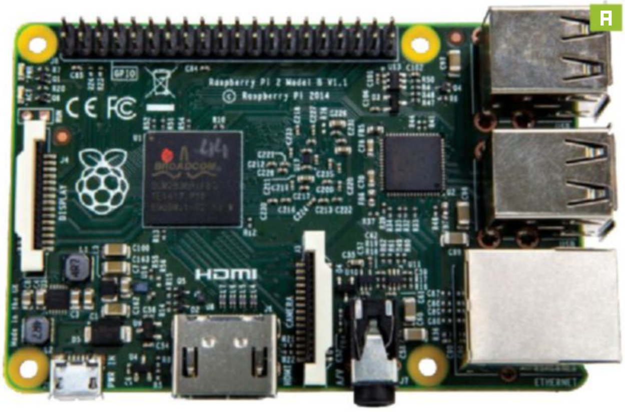
YOU'LL NEED THIS

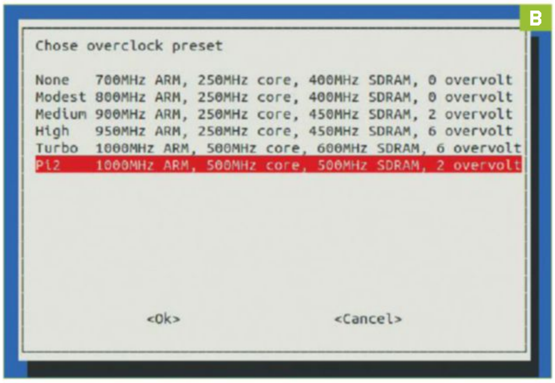
RASPBERRY Pi 2
The brilliant mini-computer costs under $45. See www.raspberrypi.org.

RETROPIE
This purpose-built distro makes it easy to play retro games.

Video games in the '80s were quite different from the latest crop of frag-'em-till-you're-dead point-and-shoot games. They were tastefully crafted, 8-bit graphical masterpieces, with an intense storyline, and gameplay that kept you engrossed for hours. If reading this makes you feel nostalgic, you're in luck, because you can emulate the golden era of gaming consoles on your modern hardware and escape back to the 1980s.

The new quad-core Raspberry Pi 2 has enough number-crunching power to recreate the video game consoles of yesteryear virtually. Most of the software that creates the defunct platforms is available as open-source software, which you can install on top of a Raspbian distro. However, the easiest way to start playing vintage games on the Raspberry Pi is to install the purpose-made RetroPie distro, which packs a bundle of emulators. –**MAYANK SHARMA**





```
Chose overclock preset

None    700MHz ARM, 250MHz core, 400MHz SDRAM, 0 overvolt
Modest 800MHz ARM, 250MHz core, 400MHz SDRAM, 0 overvolt
Medium 900MHz ARM, 250MHz core, 450MHz SDRAM, 2 overvolt
High    950MHz ARM, 250MHz core, 450MHz SDRAM, 6 overvolt
Turbo  1000MHz ARM, 500MHz core, 600MHz SDRAM, 6 overvolt
Pi2     1000MHz ARM, 500MHz core, 500MHz SDRAM, 2 overvolt
```

1 INSTALL RETROPIE

You can manually install RetroPie on top of an existing Raspbian distro but it's more convenient to use the pre-baked image. In addition to the Raspberry Pi 2 [Image A], the distro works with the older models as well, so make sure you grab the correct image. You need to transfer this image to at least a 4GB card, either using the "dd" command in Linux, such as

```
dd if=retropie-rpi2.img of=/dev/sdd
```

or with the Win32 Disk Imager app in Windows. You also need a USB keyboard and mouse for some initial setup that you can't do remotely via SSH. We'll hook up a compatible Wi-Fi adapter to the Raspberry Pi, too, which won't work straight out of the box, but we'll get to that later. Most important, make sure you grab some gaming controllers to enjoy the games to the hilt. RetroPie can work with various controllers, from cheap no-names ones to PS3 and Xbox 360 controllers.

» Once you have prepared the memory card with the RetroPie image, insert it into the Pi, connect the controller, the Wi-Fi adapter, the speakers, and the USB input devices, hook it up to your HDMI monitor, and power it up. The Pi boots directly into Emulation Station, which is the graphical

UPGRADE RETROPIE

The RetroPie script is a wonderful tool that you can use to convert a stock Raspbian distro into the ultimate arcade machine. Or, if you are already running a version of RetroPie, you can use the script to update to a newer version, without downloading and reinstalling the whole thing all over again.

To upgrade your installation, exit Emulation Station and enter the following in the CLI:

```
$ sudo apt-get update
$ sudo apt-get upgrade
```

The above commands refresh the distro's repositories, and bring it up to date by re-installing any outdated packages. With the base distribution updated, it's now time to update the various gaming emulators. Again on the CLI, type:

```
$ cd RetroPie-Setup
$ sudo ./retropie_setup.sh
```

As you are in the script, the first task is to update the RetroPie-Setup script itself.

The script lists two different upgrade options at the top. The first one fetches pre-built binaries of the emulators, while the second one compiles them from source. The former option is faster, while the latter, although excruciatingly slow on the Raspberry Pi, fetches the bleeding-edge versions of the emulators. You can safely ignore the second option, and just go with the first one, which downloads and sets up new versions of all of the emulators.

interface it uses to enable you to switch between emulators. The interface asks you to configure the controller. However, before we do that, we have to tweak a couple of settings. Press the F4 key on the keyboard to exit the Emulation Station, then head to the CLI.

2 BASIC SETUP

The first order of business is to expand the image to take over the entire card. Bring up Raspbian's configuration utility with

```
sudo raspi-config
```

and select the first option to expand the filesystem. Once that's done, head to the second option to change the default password for the pi user.

» Next, head to "Advanced Options" and select the "SSH" option to enable remote access. To ensure you use the maximum memory for gaming, head to the "Memory Split" option. If you're using a Raspberry Pi 2, allocate 512 to the GPU. Users of the older B+ model should earmark 256. Finally, scroll down to the "Overclock" option [**Image B**], where users of the Raspberry Pi 2 should select the "Pi2" option. Once done, head back to the main menu and select "Finish" to restart the Raspberry Pi and bring the changes into effect.

3 CONFIGURE WI-FI ADAPTER

When you're back up again, press F4 once more to exit out of Emulation Station. We'll now get the Wi-Fi adapter to work. Open the configuration file with

```
sudo nano /etc/network/interfaces
```

and then change its contents to resemble the following:

```
auto lo
iface lo inet loopback
iface eth0 inet dhcp

allow-hotplug wlan0
auto wlan0
iface wlan0 inet dhcp
    wpa-ssid "Your Wireless Network Name"
    wpa-psk "Your Wireless Network Password"
```

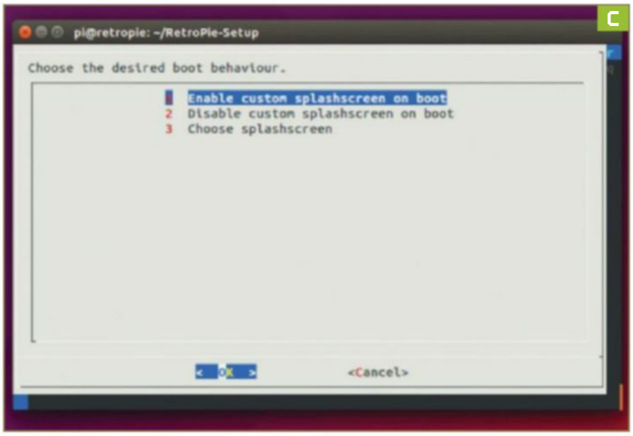
Replace the text between the " " with the SSID and password for your Wi-Fi network. Press Ctrl-X to save the file and exit the text editor. Now reboot the Pi with "sudo reboot." Once it comes back up, your Wi-Fi adapter connects you to your router. From this point on, you can do the configuration remotely from another computer.

» Exit Emulation Station yet again, and make a note of the IP address RetroPie has been assigned by your router. Assuming it is 192.168.3.111, you can now log in to it from another computer with

```
sudo ssh pi@192.168.3.111.
```

» Irrespective of how you access the Pi, you must now tweak the RetroPie settings. Change to the "RetroPie-Setup" directory with

```
cd ~/RetroPie-Setup
```



C

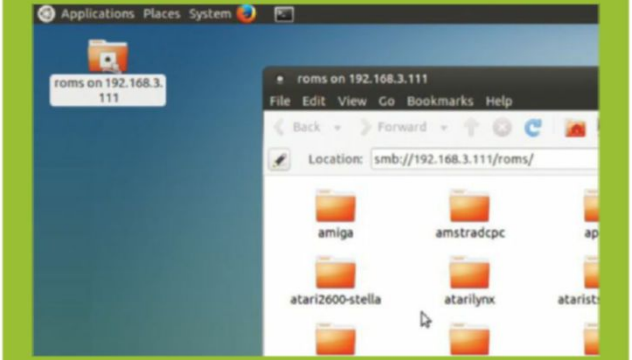
```
pi@retropie: ~/RetroPie-Setup

Choose the desired boot behaviour.

          1  Enable custom splashscreen on boot
          2  Disable custom splashscreen on boot
          3  Choose splashscreen

        <  OK  >            <Cancel>
```

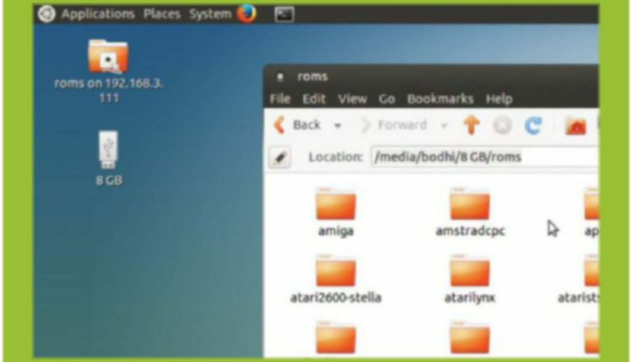
TRANSFER ROMS



Applications Places System
roms on 192.168.3.111
roms on 192.168.3.111
File Edit View Go Bookmarks Help
Back Forward
Location: smb://192.168.3.111/roms/
amiga
amstradcpc
atari2600-stella
atarilynx

1. NETWORK TRANSFERS

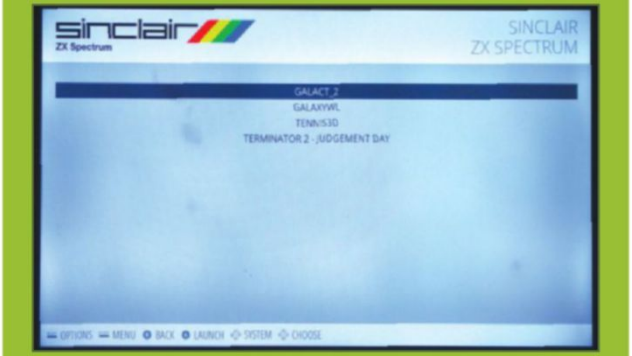
If RetroPie is connected to your router, you can transfer game ROMs to it from any computer on the same network. The distro ships with a pre-configured Samba server, and shows up as a Windows share. Copy the ROMs inside the directory for their particular emulator.



Applications Places System
roms on 192.168.3.111
8 GB
roms
File Edit View Go Bookmarks Help
Back Forward
Location: /media/bodhi/8 GB/roms
amiga
amstradcpc
atari2600-stella
atarilynx

2. VIA USB

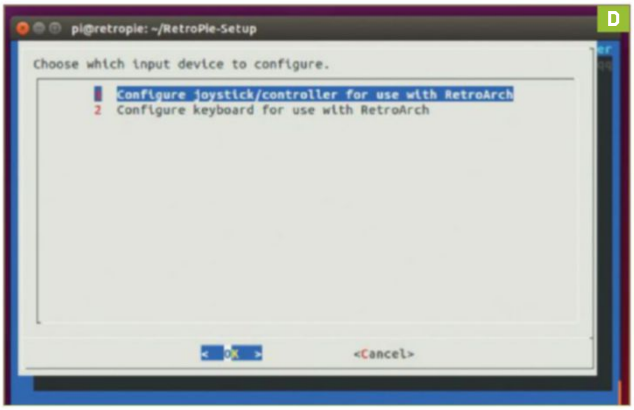
The easiest way to transfer ROMs is to use a USB flash drive. When it detects a USB disk, RetroPie creates a directory structure for ROM files that mirrors the emulators installed on the distro. Wait a while as it creates the directories and then remove the drive.



sinclair
ZX Spectrum
SINCLAIR
ZX SPECTRUM
GALACT_2
GALAXYWL
TENNIS3D
TERMINATOR 2 - JUDGEMENT DAY
OPTIONS MENU BACK LAUNCH SYSTEM CHOOSE

3. PLUG AND PLAY

Now put that USB stick into your desktop PC, and copy the ROMs on to it, making sure to put them in the right folder. When you put this memory stick back in your Pi, RetroPie pulls the ROMs into the matching directory for the associated emulators automatically.



D

```
pi@retropie: ~/RetroPie-Setup

Choose which input device to configure.

    1  Configure joystick/controller for use with RetroArch
    2  Configure keyboard for use with RetroArch

            <  OK  >            <Cancel>
```

and execute the configuration script with

```
sudo ./retropie_setup.sh
```

The script fetches any required packages that are missing from your installation. When it's ready, the script displays an Ncurses-based menu. First up, scroll down to the second-to-last option, which updates the RetroPie-Setup script itself. Once it's done, re-launch the script and scroll down to the third option, labeled "Setup/Configuration."

4 ADJUST AUDIO

In here, scroll down and select option "323," which makes the necessary changes to display the RetroPie configuration menu in Emulation Station. This helps you make changes to the distro without heading back to the CLI interface. Now, depending on your audio gear and how it's connected to the Raspberry Pi, you might need to hand-hold RetroPie before it can send audio output correctly. Select option number "301" to configure the audio settings. If the default auto option isn't playing any sound, scroll down and select the output to which your speakers are connected. The menu also gives you the option to bring up the mixer to adjust the volume.

5 CONFIGURE CONTROLLERS

Now reboot the distribution one last time, and this time continue with Emulation Station. If you've connected your controller, the distro picks it up. Press and hold any key on the controller to help the distro correctly identify it. It then asks you to map the keys on the controller. Be aware that this basic mapping is only for navigating the graphical interface, and helping you switch between the emulated system and selecting a game. Once you've set up the controller, you're dropped into the main menu of the Emulation Station interface.

» Now, to set up the controller for gaming, head to the "RetroPie" menu in Emulation Station, and select "Configure RetroArch Keyboard/Joystick" [**Image C**]. Use the keyboard to select the first option, labeled "Configure Joystick/Controller." Then follow the on-screen prompts to set up your controller. If your controller doesn't have the buttons you're being asked for, just wait for a few seconds and the setup will move on to the next button.

ANOTHER PI TUTORIAL NEXT MONTH

6 INSTALL CONTROLLER DRIVERS

If you use an Xbox 360 or a PS3 controller, you first have to install their drivers before RetroPie can pick them up. In earlier versions, this involved some hacking on the command line. However, in the latest version of the distro, it's a very simple and straightforward affair. Head to the "RetroPie-Setup" option in the "RetroPie" menu inside Emulation Station. This brings you to the Ncurses menu of the RetroPie-Setup script we were in earlier. Use the keyboard to select the third option to configure the distro. Scroll through the list and select the relevant option to install the driver for your controller—number "318" to install the PS3 driver, and number "332" to install the driver for the Xbox 360 controller.

» The Xbox360 script downloads the xboxdrv driver and edits the "/etc/rc.local" file to start the driver on boot. The script adds entries for wired 360 controllers. If you are using wireless controllers, open the "/etc/rc.local" file in a text editor, hunt for the lines that begin with "xboxdrv," and replace the "--id option" with "--wid."

7 TWEAK FOR PS3 CONTROLLERS

If you are using PS3 controllers, once you've installed the drivers using the script as described earlier, you're prompted to plug in the Bluetooth adapter for the controllers. Even after you do so, RetroPie will fail to detect your controllers. This is to be expected, according to the developers. Exit the script and out of Emulation Station. Once you're back on the command line, switch to the "/opt/retropie/supplementary/ps3controller/" directory and type

```
sudo ./sixpair
```

This nifty little utility should detect the Bluetooth adapter and make it known to RetroPie.

USE A VIRTUAL GAMEPAD

Don't sweat if you don't have a gaming controller—you can create and use a virtual one from within your smartphone or tablet instead.

To create the virtual gamepad, head to the CLI and enter the following commands to install the required components:

```
$ sudo apt-get update
$ sudo apt-get upgrade
$ wget http://node-arm.herokuapp.com/node_latest_armhf.deb
$ sudo dpkg -i node_latest_armhf.deb
```

Once you have the components, switch to the root user with the "su" command. You're prompted for the root user's password ("raspberry"). Once authenticated, enter:

```
# git clone https://github.com/miroof/node-virtual-gamepads
# cd node-virtual-gamepads
# npm install
# npm install pm2 -g
```

The above steps take a little time to complete. Once they've finished, you can launch the controller and enable it to start up automatically at boot:

```
# pm2 start main.js
# pm2 startup
# sudo pm2 save
```

Now grab your phone or tablet, open the web browser (the developers recommend Google Chrome for best results), and enter the IP address of the Pi in the address bar. You should now see a virtual controller on the page. Note that you need to configure your controller with Emulation Station and RetroArch, just as you would with a physical controller. The game controller web application also provides haptic feedback—if you find it irritating, you can deactivate it by taking your device off vibration.

» Now reboot the Raspberry Pi and, once it's back up, change to the "/dev/input" directory, and list its contents with "ls." If your controller has been detected, it's listed as "js0." You can test the controller by using

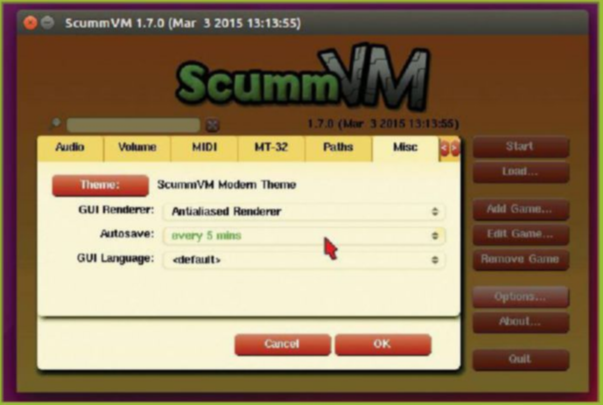
```
jstest /dev/input/js0
```

which brings up the jstest program, designed to test the features of a controller. Now head back to the "RetroPie" menu in Emulation Station, and use the "Configure RetroArch Keyboard/Joystick" option to set up your controller [**Image D**]. And that's it—your controllers are now all set up and ready to go. You can do this with all your controllers, and RetroPie saves the configuration and automatically loads it whenever you plug the controller in.

8 START GAMING!

You can now scroll through Emulation Station and play the pre-installed games with the game controllers you've set up. When you're done with those games, follow the walkthrough on page 63 to transfer your own gaming ROMs into RetroPie. There are several sites, such as World of Spectrum (www.worldofspectrum.org), that host legally downloadable ROMs for free, donated or abandoned by their developers. True retro gaming fans will have created their own ROMs from old cartridges, though, which isn't too tricky, thanks to adapters such as the Retrode.

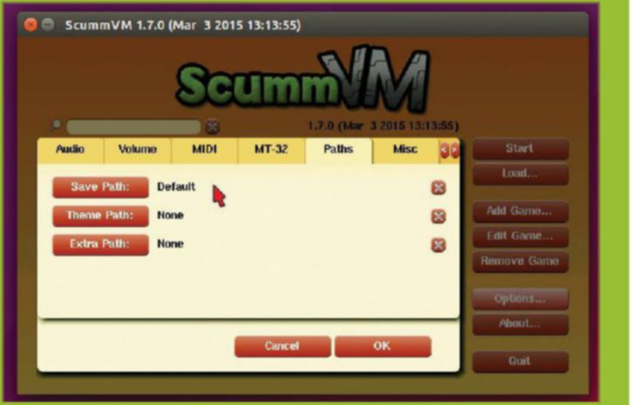
PLAY GAMES IN SCUMMVM


ScummVM 1.7.0 (Mar 3 2015 13:13:55)
ScummVM
1.7.0 (Mar 3 2015 13:13:55)
Audio
Volume
MIDI
MT-32
Paths
Misc
Start
Load...
Add Game...
Edit Game...
Remove Game
Options...
About...
Quit
Cancel
OK

Theme: ScummVM Modern Theme
GUI Renderer: Antialiased Renderer
Autosave: every 5 mins
GUI Language: <default>

1. CONFIGURE SCUMMVM

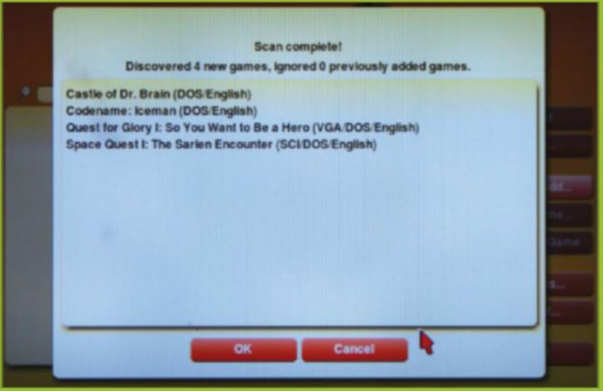
Start the launcher and click on "Options." Switch to the last tab, which houses miscellaneous settings. Use the "Theme" button to change the visual appearance of the launcher. The "GUI Renderer" setting defines how the launcher is rendered, and the "Autosave" option controls the length of time that ScummVM waits between saves.


ScummVM 1.7.0 (Mar 3 2015 13:13:55)
ScummVM
1.7.0 (Mar 3 2015 13:13:55)
Audio
Volume
MIDI
MT-32
Paths
Misc
Start
Load...
Add Game...
Edit Game...
Remove Game
Options...
About...
Quit
Cancel
OK

Save Path: Default
Theme Path: None
Extra Path: None

2. DEFAULT PATHS

Switch to the "Paths" tab to configure where ScummVM looks for particular files. The "Save Path" option points to the default folder where ScummVM stores saved games. If the option isn't set, saved games are stored in the current directory. Then there's "Theme Path," which points to the directory that stores additional themes for the launcher.

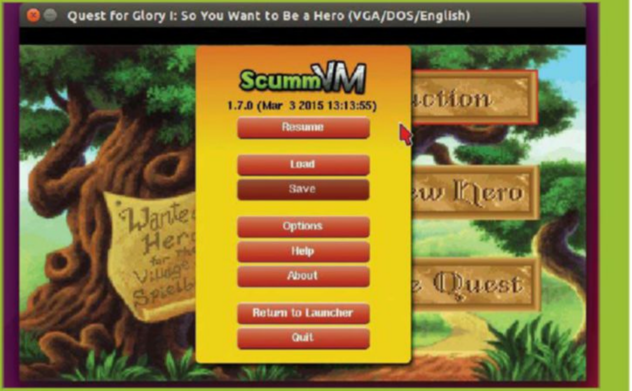


Scan complete!
Discovered 4 new games, ignored 0 previously added games.

Castle of Dr. Brain (DOS/English)
Codename: Iceman (DOS/English)
Quest for Glory I: So You Want to Be a Hero (VGA/DOS/English)
Space Quest I: The Sarien Encounter (SCI/DOS/English)

3. ADD GAMES

To load a supported game into ScummVM, copy its data files from the original media. If you've downloaded the files from ScummVM's website, you have to extract them before copying them into RetroPie. Then run ScummVM, press "Mass Add," and point ScummVM to the extracted folder. It auto-detects any games in there, and they appear in the game list.


Quest for Glory I: So You Want to Be a Hero (VGA/DOS/English)
ScummVM
1.7.0 (Mar 3 2015 13:13:55)
Resume
Load
Save
Options
Help
About
Return to Launcher
Quit

4. GLOBAL MENU

Select the game you wish to play, and press "Start." While playing the game, you can press Ctrl-F5 to pause the game and bring up the global menu. This gives you the option to get help and influence gameplay. Using the "Help" button, you can access any in-game help documentation, while the "Options" button enables you to tweak certain settings, such as volume.

Protect Windows 10

YOU'LL NEED THIS

WINDOWS 10
There are solutions for other versions of Windows.

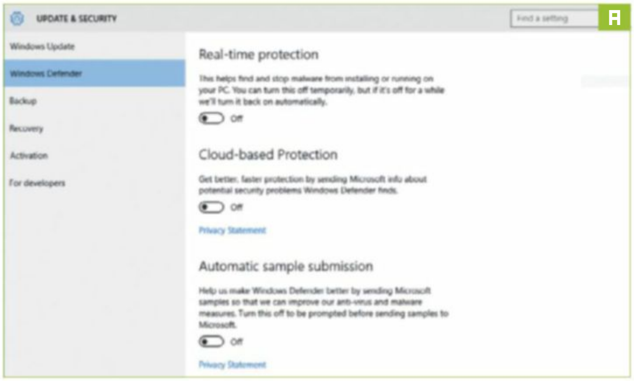
WHEN YOU'RE A PC, everything is out to get you. You need to learn how to shut the door on malicious software, and clean it out if it does take hold.

We already know that you don't browse movie streaming sites, frequent dating services populated by young ladies from the former Soviet Union who occasionally use stock photos as profile pictures, or merrily execute every .exe attachment you discover in your email spam folder—but even though you're a paragon of online virtue, there are still things you can do to protect your PC.

As a responsible Windows 10 user, you're probably already doing them. You chose "Express Settings" at install or flicked the button marked "Help protect your PC," and allowed Windows to download and install updates.

There are also third-party applications you can install to help protect against and remove malware should it somehow become resident on your PC. However, the old advice against having two antivirus apps installed at the same time still holds: They can clash, and report each other as potentially unwanted programs.

The best way to keep your PC clean is to be careful where you point your browser. In fact, never go on the Internet again, like your mother told you. –**IAN EVENDEN**



Real-time protection

This helps find and stop malware from installing or running on your PC. You can turn this off temporarily, but if it's off for a while we'll turn it back on automatically.

Off

Cloud-based Protection

Get better, faster protection by sending Microsoft info about potential security problems Windows Defender finds.

Off

Privacy Statement

Automatic sample submission

Help us make Windows Defender better by sending Microsoft samples so that we can improve our anti-virus and malware measures. Turn this off to be prompted before sending samples to Microsoft.

Off

Privacy Statement

1 SWITCH ON WINDOWS DEFENDER

If you used Express Settings when you installed Windows 10, or bought your PC with the OS already installed, then Windows Defender is probably already switched on. To check, click "Control Panel → Update & Security → Windows Defender," and if it looks like [**Image A**], panic and switch all three options on. If you've got concerns about what Microsoft is doing with your data—maybe you have something terrible to hide—then only switch on the top option. The other two send data about malware threats on your PC to MS, and enroll you in the program now known as Microsoft Active Protection Service, which was renamed possibly because its previous name of Microsoft SpyNet was too terrifying.

2 UPDATE DEFENDER

Keeping Windows Defender updated is important. The malware definitions should update automatically, but if you open Windows Defender and it warns you it's out of date, click the "Update" tab, and hit "Update Definitions" to start the process.

3 SCAN YOUR PC

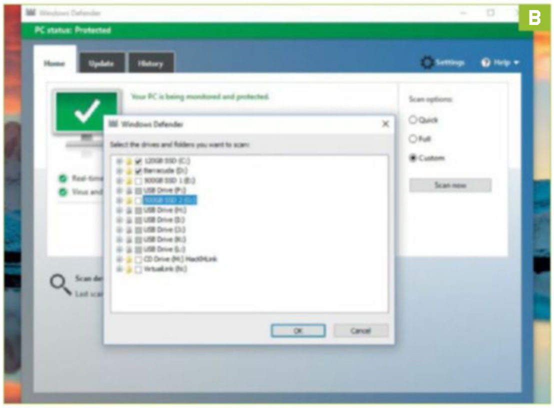
Using Windows Defender to run a scan every now and then doesn't hurt, and you have a choice of three kinds. Quick is the scan you should do most often. It only looks in places malware is likely to be found, and doesn't take up too much time. A Full scan looks everywhere, and is most often used after an infestation has been taken care of, to mop up any stragglers. Custom [**Image B**] enables you to specify which drives and folders are scanned. We struggle to think of a reason why you'd want to do this—maybe if you've got some files that are notorious for giving false-positive results, or you have a lot of data that's known to be clean, and you want to save time. Either way, the option is there if you need it.

4 CHOOSE YOUR BROWSER

Even when Windows Defender is switched on, there's still no excuse for not following a few best-practice rules when killing time on the Internet. Use a modern browser that's kept up to date—the Edge browser that ships with Windows 10 is actually very good in terms of security, justifying the break with Internet Explorer's security-risk-riddled legacy. Google's Chrome browser is a good choice, and has an offshoot—the Epic Privacy Browser (www.epicbrowser.com)—which blocks pretty much everything.

5 A SECURE ALTERNATIVE

Another option, and another Chrome-a-like, is online security company Comodo's Dragon browser (there's an Ice Dragon variant based on Firefox if you prefer). Comodo maintains its own DNS system, which you can choose to use either for just the browser or for your whole PC when you install Dragon [**Image C**]. Comodo's DNS filters out the addresses of known malware providers, but there's another feature that makes Dragon even more secure: Virtual Mode. Entering this means

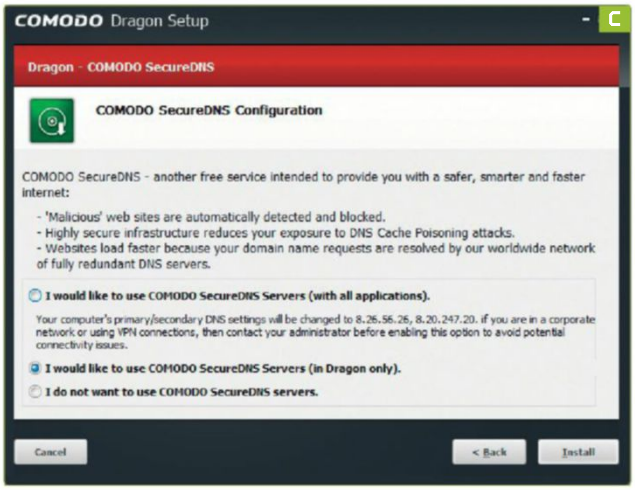


PC status: Protected

Your PC is being monitored and protected.

Select the drives and folders you want to scan:

Scan options:
○ Quick
○ Full
● Custom


C
COMODO Dragon Setup
Cancel
< Back
Install

Dragon - COMODO SecureDNS

COMODO SecureDNS Configuration

COMODO SecureDNS - another free service intended to provide you with a safer, smarter and faster internet:

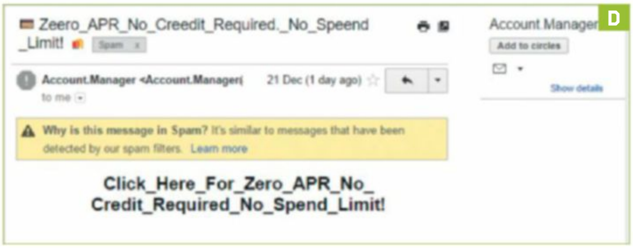
- 'Malicious' web sites are automatically detected and blocked.
- Highly secure infrastructure reduces your exposure to DNS Cache Poisoning attacks.
- Websites load faster because your domain name requests are resolved by our worldwide network of fully redundant DNS servers.

○ I would like to use COMODO SecureDNS Servers (with all applications).

Your computer's primary/secondary DNS settings will be changed to 8.26.56.26, 8.20.247.20. if you are in a corporate network or using VPN connections, then contact your administrator before enabling this option to avoid potential connectivity issues.

● I would like to use COMODO SecureDNS Servers (in Dragon only).

○ I do not want to use COMODO SecureDNS servers.


D
Spam
Add to circles
Show details

Zeero_APR_No_Creedit_Required._No_Speend_Limit!

Account.Manager <Account.Manager(21 Dec (1 day ago)

to me

Account.Manager

Why is this message in Spam? It's similar to messages that have been detected by our spam filters. Learn more

Click_Here_For_Zero_APR_No_Credit_Required_No_Spend_Limit!

installing Comodo's Internet security package, which you may not want to do, but once it's there, you can run a browser that's isolated from the rest of your system—no matter where you choose to stick it, no harm can come to the rest of your PC.

6

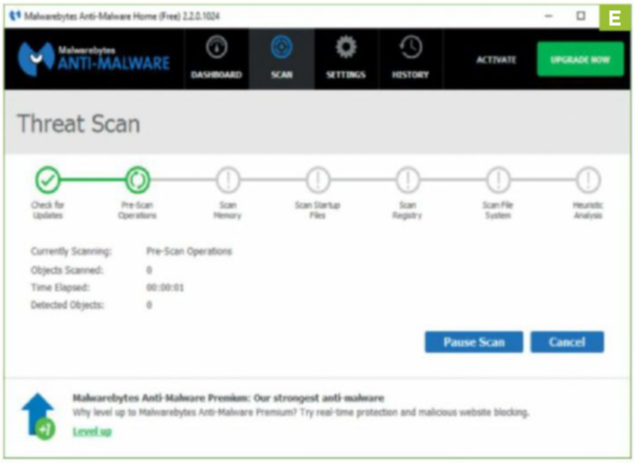
CHECK QUARANTINED FILES

If the worst does happen, and that beguiling email from a dating site you don't remember signing up to turns out to be too good to be true [**Image D**], a Windows Defender scan will flag the attachment you downloaded as infected and quarantine it. Quarantined files are viewed from the History tab, from where you can choose to delete them or, if you're sure they really contain the pictures they claim to, allow them to run.

7

GET A SECOND OPINION

Malwarebytes (www.malwarebytes.org) is a program that will run happily alongside Windows Defender, and is well worth having. There's a free version, which will, of course, bug you to upgrade to the paid version, which offers real-time protection like Windows Defender [**Image E**]. If Windows is acting up and Defender can't find anything, a scan with a second application can sometimes turn up the culprit.

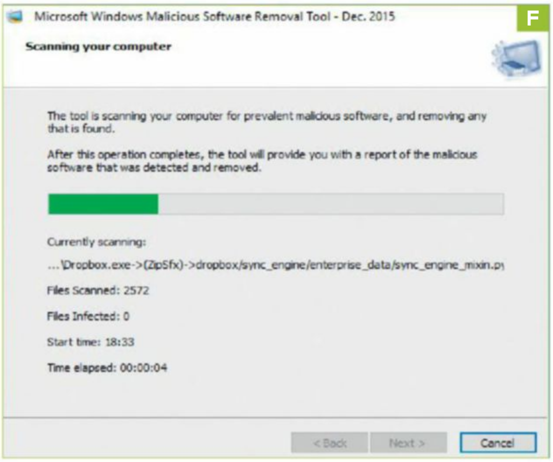

E
Malwarebytes Anti-Malware Home (Free) 2.2.0.1024
Malwarebytes ANTI-MALWARE
DASHBOARD
SCAN
SETTINGS
HISTORY
ACTIVATE
UPGRADE NOW
Check for Updates
Pre-Scan Operations
Scan Memory
Scan Startup Files
Scan Registry
Scan File System
Heuristic Analysis
Pause Scan
Cancel
Level up

Threat Scan

Currently Scanning: Pre-Scan Operations
Objects Scanned: 0
Time Elapsed: 00:00:01
Detected Objects: 0

Malwarebytes Anti-Malware Premium: Our strongest anti-malware

Why level up to Malwarebytes Anti-Malware Premium? Try real-time protection and malicious website blocking.


F
Microsoft Windows Malicious Software Removal Tool - Dec. 2015
< Back
Next >
Cancel

Scanning your computer

The tool is scanning your computer for prevalent malicious software, and removing any that is found.

After this operation completes, the tool will provide you with a report of the malicious software that was detected and removed.

Currently scanning:

...\Dropbox.exe->(ZipSfx)->dropbox/sync_engine/enterprise_data/sync_engine_mixin.p

Files Scanned: 2572

Files Infected: 0

Start time: 18:33

Time elapsed: 00:00:04

8

RUN A MALWAREBYTES SCAN

Once installed, Malwarebytes will update itself and then ask you to run a scan—this took less than four minutes on our test PC with 3TB of storage on board, but it may take a little longer if you have a lot of data for it to sort through.

9

REMOVE MALICIOUS SOFTWARE

There's one more Microsoft solution if you're sure your computer is infected and you need something to clean it out—the Malicious Software Removal Tool (http://bit.ly/1YuQBRE) [**Image F**]. MS sneakily attempts to add a script to change your default search engine to Bing with the download, but uncheck that and the 50MB file can be downloaded. In action, the tool looks a lot like Windows Defender, with options for Quick, Full, or Custom scans.

10

ALL SET

Rather than block malicious programs from running, the MSRT deletes them once they're installed, so is a way of fighting back rather than a defense. If you follow the advice in *Maximum PC,* and don't trust every link and email attachment you come across, you shouldn't need to use it. ⏻

FALSE POSITIVES

A false-positive result occurs when an anti-malware app thinks a file is malicious when it isn't. A common trick to infect the unwary is to claim a download is innocuous but will trigger a false positive, and this is almost always a lie. The best advice is to not run a file unless you are completely sure of its origin and trust the source.

The detection of malicious files through their actions is known as "heuristics," and Malwarebytes includes it in its scans. Heuristics is most useful for detecting unusual activity, say a supposed image file that contains executable code. If you've got a script that makes changes to your system that uses the same methods as a known virus, a heuristic analysis could flag it as malicious.

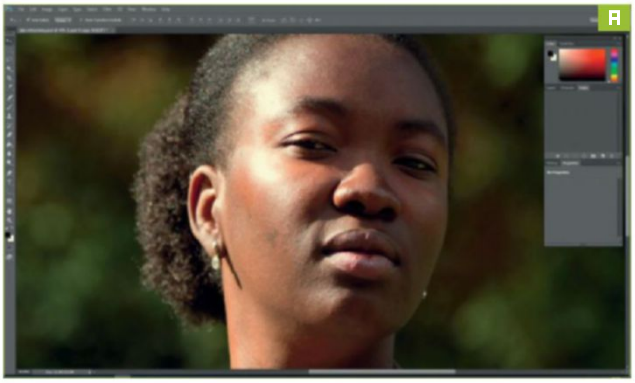
Retouch Skin in Adobe Photoshop

YOU'LL NEED THIS

PHOTOSHOP CC
Subscribe to various Adobe packages at www.abobe.com.

THE SELFIE IS AN APT ICON FOR OUR NARCISSISTIC AGE. Being able to stare into the limpid pools of your own eyes is one thing, but taking such a picture without the assistance of someone else elevates it to new levels of self-love. Other people are only needed when you share your picture online, and they press a "Like" button, or post an adoring comment.

But how to get more adoration while gazing into the reflective surface of the Internet? You can start by retouching your skin, because no matter how much you moisturize, there will still be some imperfections. Happily, Photoshop can sweep them all away—but it's important not to go too far and end up with a complexion that's on the smooth side of Barbie's butt. The "beauty" modes built into smartphone cameras push things too far this way, so it's better to edit your images after you've taken them, rather than letting an app's guesswork make all the decisions. –**IAN EVENDEN**



1

GET TO WORK

This photo was taken in bright sun, and as a result is suffering from some highlight hotspots, especially on the left of the model's face [**Image A**]. For now, we need to get stuck in with the skin retouching—and that means the Healing Brush in Photoshop CC or Elements. Click the "Spot Healing" tool (J), set it to an appropriate size, and choose "Context Sensitive" as the "Type." Then click on every spot and blemish you can see.

2

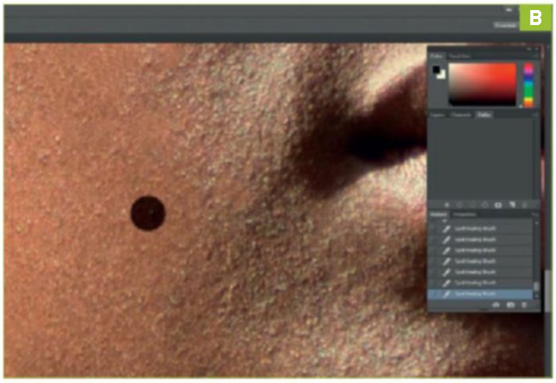
ZOOM IN

The context-sensitive nature of the brush means it tries to blend the repair in with the surrounding pixels, and a lot of the time it succeeds [**Image B**]. If a repair looks unnatural or just plain wrong, though, hit Ctrl-Z and try again, perhaps softening the edge of the brush a bit. Work while zoomed in, because your aim is for nobody to know you were ever there, like a CIA agent at the site of a presidential assassination.

3

CREATE LAYERS

That was the easy bit. In order to soften the skin further, we're going to make use of Photoshop's layers—one of the most powerful and versatile features of the program. Open the "Layers" palette ("Window → Layers" or F7) [**Image C**], and double-click the layer called "Background." This turns it into a normal layer. Then right-click it and select "Duplicate Layer" twice, so you now have three layers, which are all the same. Give them appropriate names—we're going to use "1" and "2," with "1" in front of "2" in the stack. We've kept "0," the original background layer, hidden as a backup.



4

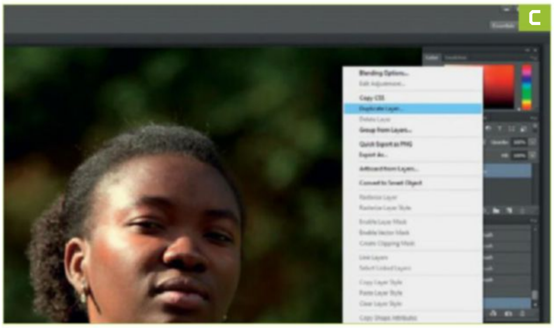
BLUR BLEMISHES AWAY

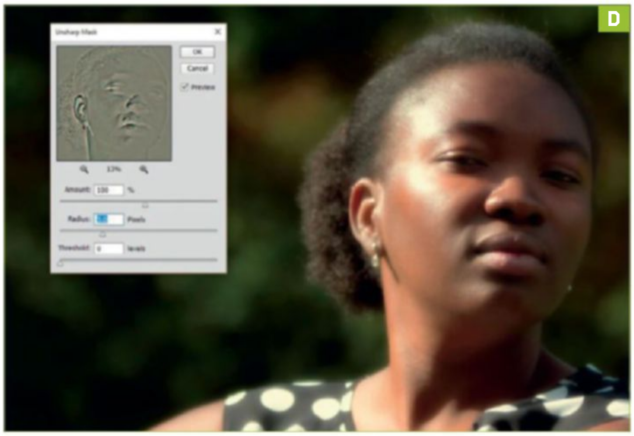
Select layer 1, the top-most layer. We're going to blur away all the skin blemishes—in fact, almost all the recognizable features—with one of the Blur filters. Experiment with the one that looks best for your subject. We're going to try Gaussian to begin with, which completely obliterates our lovely young model's features. Surface Blur is another filter worth trying, and if you're patient, give Smart Blur a go for the most options—but also the longest processing time before you see the result.

5

APPLY IMAGE

When you've settled on a blur (you might find yourself going back and trying it several times before you're happy), "OK" it, and with layer 1 still selected, go to the "Image" menu and select "Apply Image"—an odd





Amount: 100 %

Threshold: 0 levels

name for a tool that blends images together. In the "Layer" field, select "2," then choose "Subtract" as your Blend Mode—your image will start to look a little strange. We've set "Scale" to "1" and "Offset" to "128"—again, play with these variables to see what looks best for your photo.

6 EXPERIMENT WITH BLEND MODES

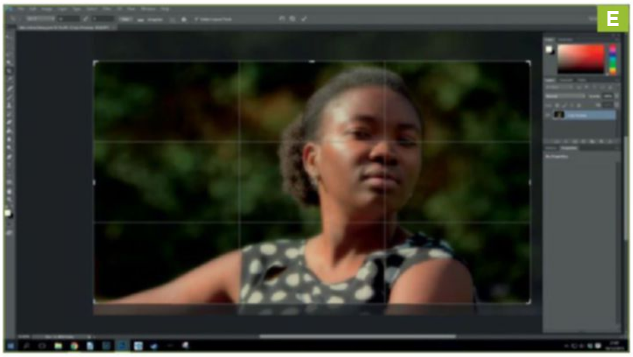
Once you've pressed "OK" on "Apply Image," head over to the "Layers" palette again, and change the "Blend Mode" of layer 1 to "Soft Light." Layer 2 should now show through layer 1, but be softened by the layer above. Change the "Blend Mode" to "Vivid Light" to get a different effect, and flick through the others to see what effect they have—you can always Ctrl-Z.

7 SOFTEN THE IMAGE

Next, we're going to alter the intensity of the softening, but in a counter-intuitive way. Select layer 1, head to the "Filter" menu, and choose "Sharpen → Unsharp Mask" [**Image D**]. The preview in the "USM" window shows the layer as it was after you used "Apply Image," but check the "Preview" box and you see the final effect applied to your full composition. What happens next sounds backward, but the more you increase the sharpening effect in "Unsharp Mask," the softer your image becomes. Don't overdo it, because it's quite possible at this stage to make it look like the photo was taken through a steamed-up bathroom window.

8 DEAL WITH HIGHLIGHTS

Finally, we can take care of those rogue highlights on the model's face. One of Photoshop CC's cleverest features (sorry Elements users) is the ability to run Adobe Camera Raw as a filter on any image. Click "Filter → Camera Raw Filter," and bring the "Whites" and "Highlights" sliders to the right, to reduce the blown-out look. We also fiddled with "Blacks" and "Clarity" before hitting "OK."



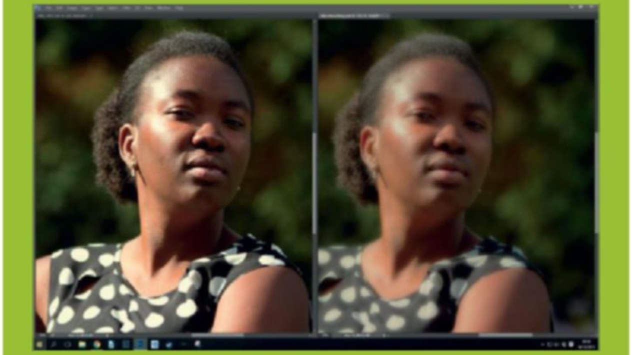
9 CROP IN

A good crop can do wonders for an image. This photo was taken with a DSLR, but to make our Instagram audience think it was taken with a smartphone, we need to crop it to 16:9. Select the "Crop" tool (C), and set the aspect ratio in the "Options" fields [**Image E**]. Then drag the crop box across the image, deciding where looks best to put it. We're taking the opportunity to place our model's eye and nose on the intersection of two of the crop box's guide lines, which are showing the Rule of Thirds.

10 SAVE AND SHARE

Save your composition as a PSD file to retain the layer structure, then select "Layer → Flatten," and save it again as a JPEG, ready to be uploaded to the Internet and adored [**Image F**]. ⏻

BLEND MODES



Photoshop's Blend Modes determine how the colors and brightness of a layer mix with those of the layer below. If a layer is set to "Normal Blend Mode" and 100 percent opacity, nothing from layers below passes through. Lower the opacity, however, and something of what's underneath starts to appear. "Multiply" mode multiplies the RGB values for each pixel with those below, resulting in a darker picture, while "Screen" does the same with the layers inverted, leading to a lighter result. The various "Light" modes and "Overlay" combine the two, performing mathematical transformations to determine the final color and brightness of each pixel. The "Dodge" and "Burn" modes lighten and darken images respectively, and are named for darkroom techniques.

BUILD IT

ALEX CAMPBELL **ASSOCIATE EDITOR**

A Home-Brewed Steam Machine

Bringing PC power to the living room

LENGTH OF TIME: **1.5 HOURS**

LEVEL OF DIFFICULTY: **EASY**

THE MISSION

THERE ARE A FEW THINGS that set apart the people who game on PCs from the folks who use consoles. For one, PC gamers often choose keyboards and mice, while console gamers just love their controllers (and usually have little choice in the matter). A PC can offer a lot more power and upgradability, while a console is stuck as-is. The biggest thing to note is where people play their games: PC gamers play at desks (mostly), while consoles rule the living room. That's what Steam machines are looking to change.

There are a few Steam machines available for sale already, and surely more to come. But as a PC builder, one must ask: Why buy one when you can build your own? Some of the prebuilt Steam machines out there aren't too different from consoles in that their hardware can't be changed. If you decide to brew your own, the world is your oyster when it comes to hardware and cases.

Steam machines also come in two flavors: SteamOS and Windows. The Windows machines come with Windows and Steam pre-installed, and aren't too different from a normal Windows desktop PC. SteamOS, on the other hand, is Valve's Linux-based OS offering. It basically runs Steam in Big Picture Mode on top of Debian 8. (Ubuntu, Valve's stated "favorite" Linux distribution, is based on Debian.)

We decided to test out Valve's OS by building a Steam machine that would run SteamOS. That means no Windows "tax," and no worrying about antivirus software annoying you with popups (or scheduled scans) while you're in-game. We couldn't resist trying it out with our own parts.

SHOVELING COAL

COMMERCIALLY AVAILABLE Steam machines tend to be a little conservative when it comes to power. The reason is simple: cost. As games will probably be running on a 1080p TV, there's no need to splurge in an attempt to chase the 4K gold at the end of the rainbow, and there's less overhead from the OS and other applications.

We chose many of the same components as we had in the Summer 2015 Budget Gamer build we made for our quarterly web version of Blueprints. That rig laid the foundation with an Asus Z97I-Plus mobo and an Intel Core i5-4590, with 8GB of Corsair Vengeance DDR3 RAM. Their new home is a slim SilverStone ML08 mini-ITX case. We also used a SilverStone SFX PSU to power the little rig, and dug up a Asus GeForce GTX 960 Strix for our video workhorse.

While the Z97 board is a little overkill considering we're going with a locked CPU, it offers plenty of options in the BIOS (as well as PWM connectors). The mobo also includes a mini-PCIe Wi-Fi card, essential for a rig is designed to run in the living room.

At the time of writing, the Z97I-Plus was hard to find (and thus dearer than its original price). If you can't find it in stock, we recommend an H97I or similar H-class board instead of the Z-class (unless you plan to pick up a K-model CPU). There are a lot of options when it comes to mini-ITX motherboards. And a Skylake-based system won't cost you much more than a Haswell one.

INGREDIENTS

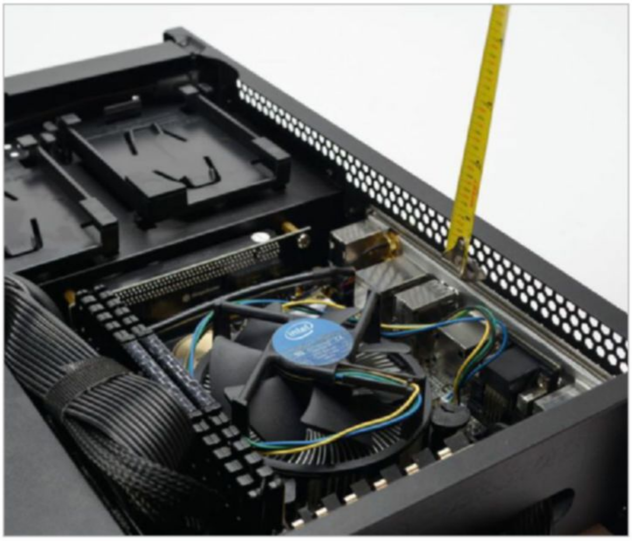
PART		STREET PRICE
CPU	Intel Core i5-4590 Haswell	$185
GPU	Asus GeForce GTX 960 Strix 4GB	$240
Mobo	Asus Z97I-Plus	$153 *(Now available for $300)*
Memory	8GB (2x 4GB) Corsair Vengeance DDR3 1600	$45
Case	SilverStone ML08B-H	$85
PSU	SilverStone SX500 500W SFX (80 Plus Gold)	$110
SSD	250GB Samsung 850 EVO M.2	$105
Total		$923

1 DON'T FORGET THE BOILER

IF THERE'S ONE BIG GOTCHA about using M.2 with mini-ITX, it's that the mount point is often on the underside of the mobo—we felt really stupid when we had everything in except the SSD. D'oh! While we've established M.2 SATA SSDs as our preferred form factor (as long as prices are on par with 2.5-inch models), the decision to go with M.2 in mini-ITX builds really pays off. Mini-ITX form factors can be hellish when it comes to airflow. With M.2, there's one less cable to route, and if it is your only storage drive, one less power cable. The only problem is that M.2 SSDs are topped out at 500GB at time of writing. Larger capacity SSDs are still pricey, and 250GB is plenty for the slim SteamOS and a decent game library. If the need arises, you could add 2.5-inch SSDs or HDDs.

2 BOYLE'S LAW

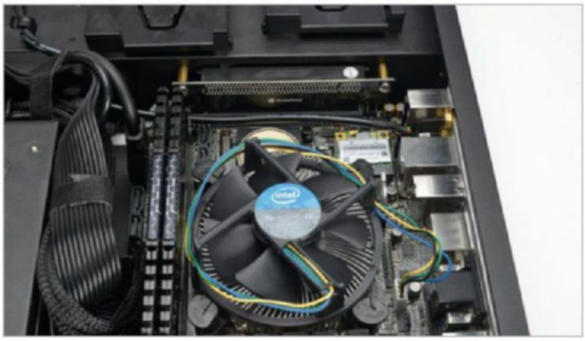
THERE ISN'T A LOT of room for CPU coolers in the ML08—there's only about three-quarters of an inch of clearance from the top of the cooler to the side panel. As we went with a fixed-clock i5-4590, we weren't too worried about the use of a stock cooler. However, if you want to go with K-model CPUs, you may want to get a better cooler for overclocking. There are few small-form-factor (SFF) coolers that would be short enough. SilverStone's Argon series is designed to work with the ML08. Corsair recently released an SFF closed-loop cooler, the Hydro Series H5, but even that could prove too thick (at 2.25 inches). If you feel the need for speed in this case, keep a close eye on your temps, as you won't have the thermal headroom you might enjoy in a bigger case. On the bright side, the side panel has a vent above the motherboard, so airflow to the CPU is unobstructed.



3

THE ELBOW PIECE

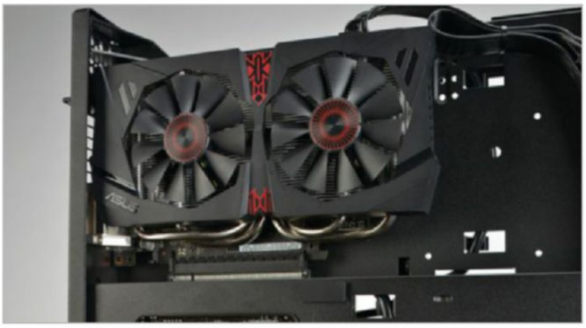
BECAUSE THE ML08 is so slim, the video card can't be mounted in the typical position, perpendicular to the motherboard. However, you can't really move the PCIe slot, so Stone supplied a hard ribbon piece that turns the slot at a right angle for you. The L-shaped hard ribbon secures in place with a pair of screws, so there's no worry about wobble wreaking havoc on your motherboard. The other thing that this piece does is allow for the two-bay design. Locating the GPU in a separate bay from the CPU and motherboard keeps their heat and cooling separate. Warm air from the GPU isn't pumped over your CPU, and vice versa. Cable management is also cleaner, because you don't have to route things around a big video card. USB, audio, and power cables are easily routed and plugged in, without concern for obstructing the video card.



4

VIDEO TURBINES

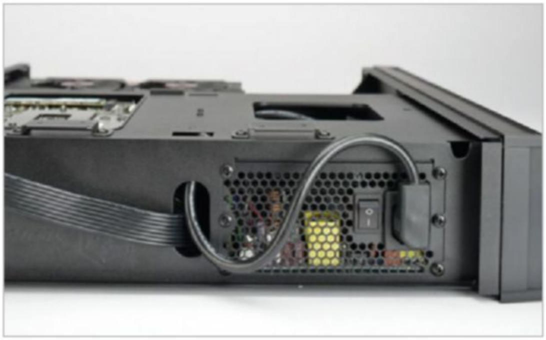
THE FIRST THING TO NOTICE about the GTX 960 Strix is that it looks so small in its bay. Indeed, we could fit a full-sized GPU—such as a GTX 900 series or R9 300 series—in here if we wanted. You'd just have to keep an eye out for big aftermarket cooling solutions. While there's room for reference model cards, mounting a card sporting three fans wouldn't work. To mount the card, there's an extra riser piece that inserts into the L-shaped PCIe ribbon. It's easy to miss, and if you don't use it, the card won't seat into the two slots properly. On the other end of the card, a cutout allows for PCIe power cables to cross the partition into the video card bay. We recommend using ribbon-style cables or individually sheathed cables, as rounded sheathing would be ungainly. This bay is also the only place to mount a 3.5-inch HDD. If you crave multiple terabytes of storage, you need a video card that's shorter than the 960 Strix.



5

CONCEALED COPPER

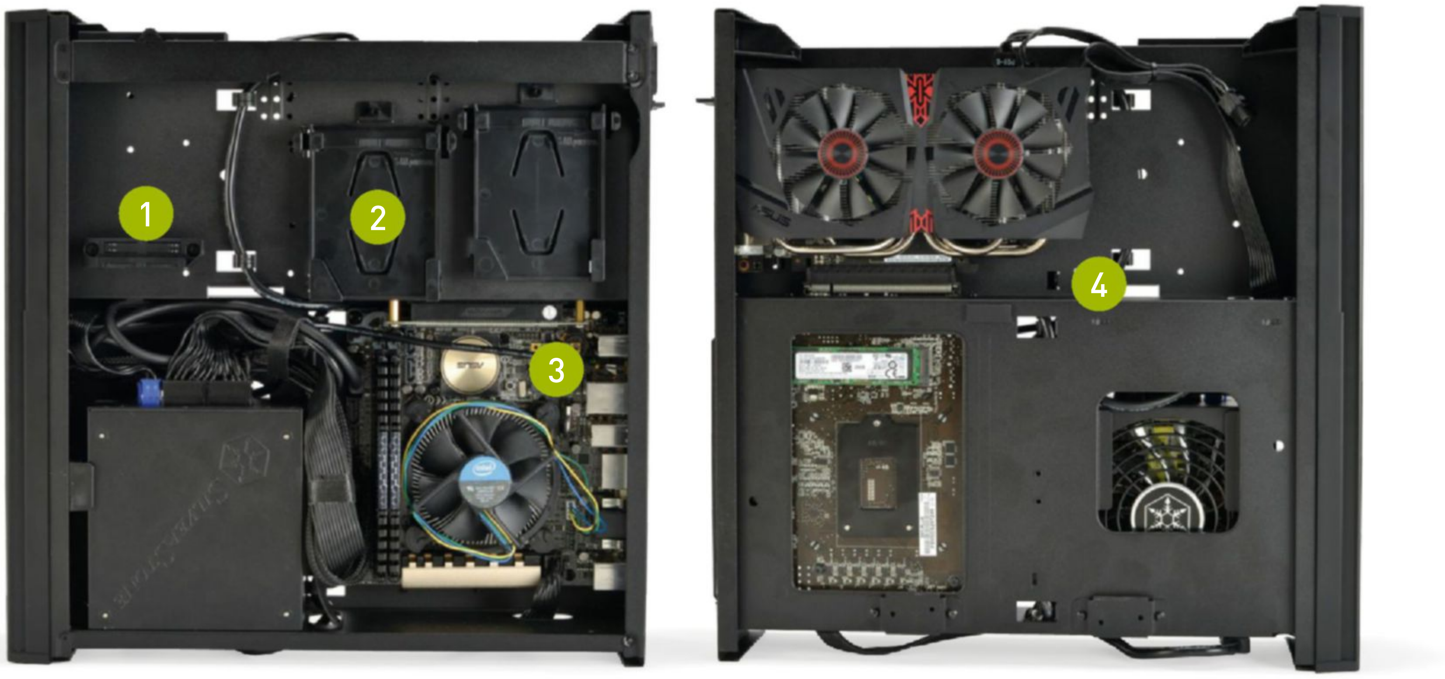
THE ML08 IS A SLIM CASE. As a result, we need a slim power supply. We installed SilverStone's 500W SFX model, which gives our rig more than enough juice. The SX500 is fully modular, so we were able to keep cabling to a minimum by going with an M.2 SSD. We used flat ribbon cables, as opposed to rounded sheathed. While rounded sheathed cables help airflow in an ATX case, flat ribbon cables are a boon for the small form factor. We folded our cables over themselves, and positioned them flat against the side of the PSU, keeping them out of the way. There was one more gotcha, though: The power supply's plug isn't exposed to the outside of the case. This means there's no way to externally switch the PSU on or off, so before you close up the case, be sure to switch it on.



6

HOT HANDLES

ONE THING THAT'S HANDY on a case is, well, a handle. It makes transportation much easier. The ML087 comes with a handle that is attached to the case with four screws, or left off if preferred. The cool feature is that the handle can be attached to either side of the case, as the side panels are symmetrical. This means there is no true "top" or "bottom" to the case, though we feel that the "right way up" has the video card bay on top. If we could improve on one thing in this case, it would be the handle. It's made of plastic that feels strong enough to support the weight of a small system, but the molding isn't the kindest shape on hands. Carrying this thing on the train and across town (yes, we tried that) leaves indentations on the fingers, and prompted us to switch hands often. This could be fixed by rubberizing the grip.



1 This mounting bracket and area allows for the addition of a slim DVD or Blu-ray drive. Adding such a drive isn't necessary for a Steam machine, though it would be nice if SteamOS would allow the playing of DVDs.

2 The main mounting points for storage is a pair of 2.5-inch brackets for SSDs or laptop HDDs. By going with an M.2 SSD, we could leave these brackets empty, though using a pair of HDDs in RAID 1 wouldn't be a bad idea for backing up games.

3 Of course, Wi-Fi is essential for an internet-connected device destined for the living room. While wired Ethernet is always best, the 802.11AC card makes sure that the Wi-Fi connection is as good as it can be.

4 A slim opening at the bottom of the video card bay is just big enough for a SATA power and data connector to attach to a 3.5-inch drive. If your video card is too long, say goodbye to the 3.5-inch HDD.

LOW ON PRESSURE

BUILDING THIS LITTLE RIG was a blast, and went by much faster than other small form factor builds we've worked on. Installing the SteamOS is easy as well, as long as you look out for a couple of things.

First of all, you need to set the Secure Boot option to "Other OS" in the BIOS. SteamOS and most other Linux distributions aren't able to supply certificates to motherboard vendors. Without a signed certificate, the BIOS will refuse to boot the OS unless you disable Secure Boot.

When we tried the automatic installation for SteamOS, the installer couldn't partition the SSD, for whatever reason. When we tried the "advanced" installation (it really isn't that advanced, as Linux installations go), everything worked just fine.

There's a dark side to playing games on Linux. The vast majority of games available on Steam are for Windows and use DirectX. Of the games for SteamOS and Linux, only a few are developed with Linux in mind, or use OpenGL as their native API. Thus, many games that are ported have to translate DirectX instructions to OpenGL equivalents somehow. That translation, coupled with slightly lower performance of Linux drivers for GPUs, can amount to big performance hits.

At every turn, the better components in this build spanked the little Alienware Steam Machine. When we compared these results to the Windows-based Alienware Alpha, the margins seemed to thin out. The frame rate in *Bioshock: Infinite* was actually lower than what the Alpha pulled off with its 860M.

SteamOS is still in its infancy. The number of titles available to SteamOS will increase, as will support for Linux if the OS starts to gain steam, so to speak. For now, building a SteamOS box is a fun experiment, but don't expect it to replace your desktop rig just yet.

BENCHMARKS

	Alienware Alpha	Alienware Steam Machine	
Bioshock: Infinite (fps)	69.5	48.1	67.8 -2.4% (Alpha) +41% (Steam)
Talos Principle (fps)	48.1	37.8	51.2 +6.4% (Alpha) +35.4% (Steam)
Half-Life 2: Lost Coast (fps)	236	231	254 +7.6% (Alpha) +10% (Steam)
Shadow of Mordor (fps)	50.7	35.4	64 +26.2% (Alpha) +81% (Steam)
			0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a 5960X CPU, three GTX 980s, and 16GB of RAM. *Arkham City* tested at 2560x1440 max settings with PhysX off. *Tomb Raider* at Ultimate settings. *Shadow of Mordor* at Max settings.

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oculus

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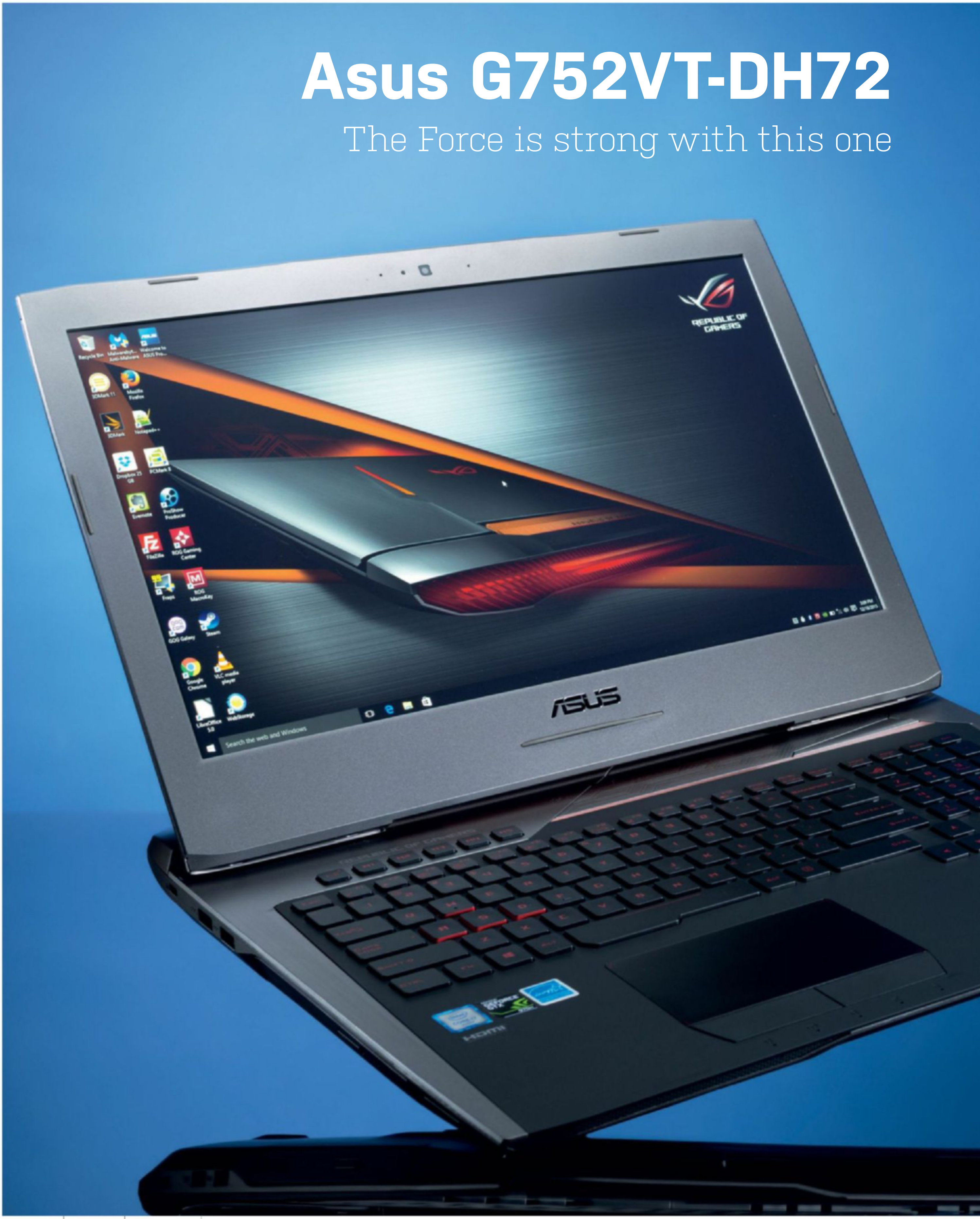
Asus G752VT-DH72

The Force is strong with this one


REPUBLIC OF GAMERS
ASUS

YOU CAN ALMOST picture the scene: the Dark Lords of Technology showing off their wares, urging Asus to join the forces of Maxwell and Skylake to rule the mobile gaming universe. Unlike in the movies, though, Asus takes the bait and delivers its updated G752VT notebook. Unfortunately, while impressive on many levels, you still have to watch out for that exhaust port weakness (which Asus oddly tries to cover with a couple of rubber grommets).

Asus routinely offers true gaming notebooks—and by "true" we mean they go with the fastest graphics cards available, not lower-tier parts with names that belie their performance (we're looking at you, GTX 950M/960M). Having been a player in this arena for so long, you'd expect the well-oiled Asus machinery to crank out improvements every year. That was the goal with the G752, and it mostly succeeds.

Any Sith Lord would be proud to carry this weapon into battle, with its aggressive lines and red/orange accents. Despite the flashy looks, the notebook doesn't attract unwanted attention in the way of noise, even during extended gaming sessions. The fans stay under 36dB, with thermals mostly below 35 C, though the exhaust area can reach a warm 45 C under load. Elsewhere, the gesture-enabled touchpad still offers two discrete buttons, and the keyboard supports 30-key rollover anti-ghosting technology—so unless you grow several extra appendages, or manage to seat more than three people around the keyboard, you'll never miss a keystroke.

YOU ARE NOT A JEDI YET

The G752VT-DH72 model here pairs a GTX 970M 3GB with a Skylake CPU, tossing in an M.2 NVMe drive for good measure. Except Asus forgot the batteries for its lightsaber and neglected to install the Samsung NVMe drivers. Oops! With the drivers installed, the SM951 NVMe zips along with peak read speeds of 2GB/s, but we have to dock points for going with a puny 128GB model. It's 2016; can't we expect 256GB SSDs as standard on a notebook costing over $1,000? 128GB means juggling files between the SSD and HDD, and while Asus offers larger SSDs on other G752 models, you'll pay much more for the privilege.

Outside of the SSD misstep, the G752VT performs admirably. It's not going to match a GTX 980M, let alone the beefy GTX 980 for Notebooks, but it will handle pretty much any game at the native 1920x1080 resolution at high to ultra settings. Compared to our aging zero-point notebook, the 970M runs circles around it and delivers up to three times the gaming performance. Even better, the IPS G-Sync display works at up to 75Hz, so even titles that don't hit 60fps will feel smooth at 40–75fps.

The notebook stumbles elsewhere, though. Depending on the application, the i7-6700HQ is either slightly faster or slightly slower than the ZP's i7-4700MQ. Meanwhile, supporting G-Sync means Asus can't use Nvidia's Optimus technology, and unlike the MSI GT72S (see Holiday 2015, page 76), the 970M is always enabled. Despite a 66Wh six-cell battery, the G752 checks out at 2.35 hours—MSI's GT72S can double its runtime by disabling the dGPU.

The GTX 980's ability to destroy benchmarks may impress, but it's insignificant compared to the power of a balanced platform. The GTX 970M remains potent, it's a far more affordable option, and G-Sync is arguably more useful on a notebook that can't routinely hit 75fps. Some of the extras increase the price, however, and we still want a 256GB SSD (that model costs $2,000), but provided you're OK with the lackluster battery life, there are no show-stoppers. Those who prefer raw power can still opt for Death Star notebooks sporting GTX 980, but the Star Destroyer G752VT is equally impressive in its own right. **–JARRED WALTON**

VERDICT
9

Asus G752VT-DH72

+ GALACTIC EMPIRE Good performance; G-Sync display; attractive styling; not too hot or loud.

− REBEL SCUM Poor battery life; large and heavy; small 128GB SSD; missing NVMe drivers.

$1,699, www.asus.com

SPECIFICATIONS

CPU	Intel Core i7-6700HQ
RAM	2x 8GB DDR4-2133
GPU	GeForce GTX 970M 3GB
Display	17.3-inch, 1920x1080 Matte 30–75Hz G-Sync-enabled IPS
Storage	128GB Samsung SM951 NVMe, 1TB HGST 7200RPM HDD, BD-Combo
Connectivity	1x Mini-DP, 1x HDMI, Ethernet, SD reader, 4x USB 3.0 (1 charging), 1x USB 3.1 Type-C, 802.11ac Wi-Fi, Bluetooth 4.0, SDXC, 3x audio
Dimensions	16.85x13.11x0.91–1.69 inches
Weight (Lap/Carry)	8.86/10.12 lb

BENCHMARKS

	ZERO-POINT	
Stitch.Efx 2.0 (sec)	962	913 (5%)
ProShow Producer 5 (sec)	1,629	1865 (-13%)
x264 HD 5.0 2nd (fps)	13.5	15.17 (12%)
BioShock Infinite 1080p DX11+Ultra (fps)	36.1	109.2 (202%)
Metro: LL 1080p "Normal" (fps)	30.4	90.1 (196%)
3DMark 11 Performance	4,170	9,593 (130%)
Battery Life (1080p Video, minutes)	234	142 (-39%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point notebook is an Alienware 14 with a 2.4GHz Intel Core i7-4700MQ, 16GB DDR3-1600, 256GB mSATA SSD, 750GB 5,400rpm HDD, GeForce GTX 765M, and Windows 7 Home Premium 64-bit. *BioShock Infinite* tested at 1920x1080 at Ultra DX11 settings; *Metro: Last Light* tested at 1920x1080 at DX11 medium quality settings, with PhysX disabled.

The black-and-silver motif goes nicely with the Sith-red backlighting.

Alienware Steam Machine

Good hardware held back by mediocre software

WE'VE BEEN LOOKING FORWARD to Valve's Steam Machine initiative for a long time, mostly because Valve has never failed us in the past. Well, there's a first time for everything, and we have to acknowledge that the company has made a misstep here.

At the frontlines of the initiative is Alienware's little 2.1x7.8x7.8-inch box. If the system looks familiar, it's because it's largely the same small PC as Alienware's Alpha system we've reviewed before. It's still super sexy, portable, and has the same ports. The biggest difference is that the Steam Machine version uses Linux (with Steam's Big Picture Mode overlay on top) instead of Windows. Also, instead of coming with an Xbox controller, the Steam Machine comes with Valve's new Steam Controller, which has a steep learning curve, but lets you play every game on Steam, and enables you to easily navigate Valve's 10-foot UI.

Our particular Steam Machine is running the same mobile graphics card that its Alienware Alpha counterpart uses—essentially a variant of Nvidia's 860M GPU. The system does offer some much-needed

Linux currently has access to roughly one-fifth of the Steam library.

enhancements, which include Intel's 3GHz Core i5-4950 quad-core CPU, 8GB of RAM, and a 7,200rpm hard drive. Conversely, our Alpha came with an i3 processor, 4GB of RAM, and a 5,200rpm HDD.

Despite the beefier hardware, the Steam Machine, with Linux, performed much worse in our gameplay benchmarks compared to the Alpha. There aren't that many Linux games with benchmarks, but we tried *BioShock Infinite, The Talos Principle,* and *Shadow of Mordor,* and all of them ran 20–30 percent worse than the Alpha, which is troubling, considering the Alpha is only a little more powerful than current-gen consoles. Playing a popular game such as *Ark: Survival Evolved* was damned near impossible at anything but the lowest settings, and then it looked like crap. To be fair, *Ark* is still in Early Access, and the game will likely be better optimized over time. Still, don't expect to run intensive games above medium settings. Only in Valve's *Half-Life 2: Lost Coast* benchmark, which uses the non-taxing Source engine, were the two systems comparable. This suggests that the other games weren't well optimized for Linux.

GAMING BY NUMBERS

Perhaps worse than the unoptimized ports, however, is the lack of games compared to Windows offerings. While Valve has done a very commendable job of increasing the number of games we get on Linux, with a total library of 3,389 at the moment, that's still only about 22 percent of titles that are available on Windows. Even Mac OS boasts a greater library, with its 5,602 games, which is disconcerting because we would never recommend a Mac for gaming. While there are some high-quality games on Linux, and we're sure more will follow, a lot of the big publishers haven't brought their big guns to Steam so far. For instance, there's no *Fallout 4, GTA V,* or *Call of Duty: Black Ops 3.* You could use the Steam Machine as a streaming box from a Windows PC, but unless you're using a wired connection, you're going to experience the same Wi-Fi latency issues as Valve's hit-and-miss Steam Link. And going with Linux, you're also missing games outside of Steam, such as titles on Battle.net and Origin. It makes more sense to bite the $100 bullet and buy Alienware's equivalent Windows box.

The Steam Machine has other issues, too. For some reason, some cloud saves didn't carry over on certain titles, and there are no native video streaming apps, such as Netflix, Hulu, or YouTube. People use their consoles for more than just gaming. Luckily, there is a browser built into Steam, so you can launch Netflix from there, but this solution isn't very elegant. What's more, the Steam Controller doesn't support a headphone jack, so you can't issue voice commands to search for things, as you can on the Xbox One or Nvidia Shield. The Steam Machine doesn't have an analog mic port either, so you have to use a USB headset to chat with friends online.

We're not sure who this is for. The key market seems to be PC gamers who won't install Windows, but how many of those exist? As we like the hardware, we suggest going with the Alienware Alpha box with Windows instead, as Alienware has made improvements to the UI, and it works well with the Steam Controller. For $100 more, the extra performance and access to every Windows game is worth it. **–JIMMY THANG**

VERDICT
6

Alienware Steam Machine

+ **ALIEN** Sexy chassis; small and portable; quiet.

− **ALIEN VS. PREDATOR** Only small portion of Windows games; lack of video streaming apps; Linux performance issues.

$650, www.alienware.com

SPECIFICATIONS

CPU	3GHz Intel Core i5-4950T
RAM	8GB DDR3
GPU	Nvidia GeForce GTX 860M
Storage	1TB 7,200rpm HDD
Connectivity	HDMI (out and in), S/PDIF, 3x USB 2.0, 2x USB 3.0, Bluetooth 4.0, 802.11ac
Carry Weight	4 lb, 8 oz

BENCHMARKS

	ZERO-POINT	
BioShock Infinite (fps)	69.5	48.1 (-30.8%)
Talos Principle	49.3	37.8 (-23.3%)
Half-Life 2: Lost Coast	235.9	231 (-2.1%)
Shadow of Mordor	50.67	35.4 (-30.1%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point is Alienware's Alpha with a 2.9GHz Intel Core i3-4130T, 8GB DDR3 RAM, a GeForce GTX 860M, and Windows 8.1. *BioShock Infinite* tested at high settings; *Talos Principle* tested at high settings; *Lost Coast* tested at max settings; *Shadow of Mordor* tested at medium settings; all at 1080p.

DELVE DEEPER INTO NATURE

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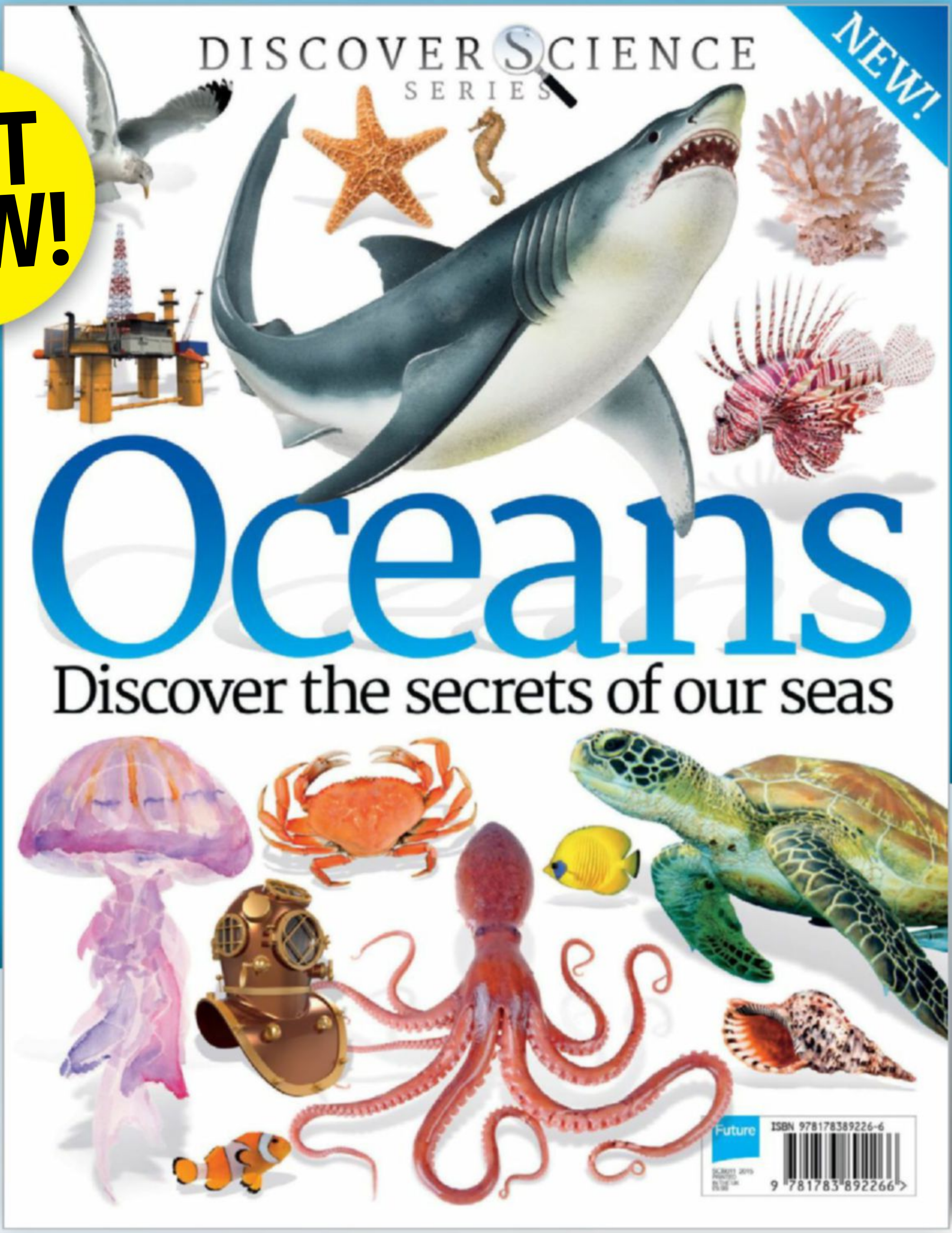
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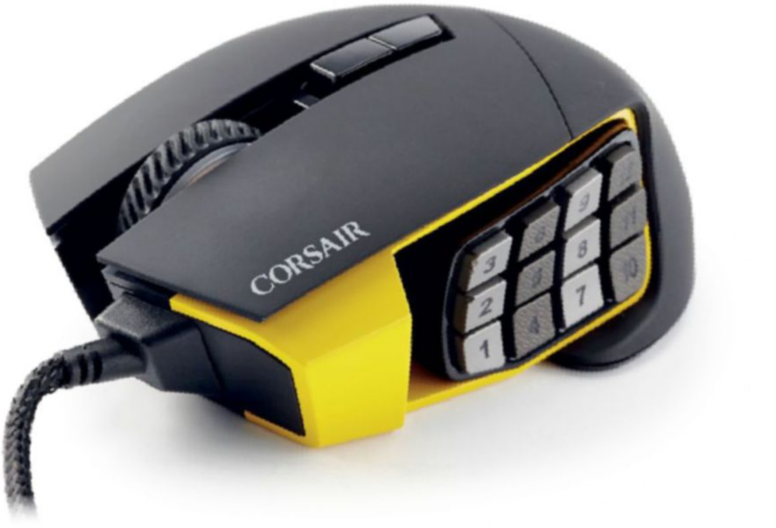
Corsair Scimitar RGB Gaming Mouse



Maniacal multi-button mayhem

WHETHER YOU'RE AFTER a multi-colored, über-ergonomic trigger stomper, or just a simple minimalistic mouse, finding the right one is always a challenge. The problem lies in the shape and form of your hand. Whether you're a palm, claw, or fingertip user, each one has different requirements, and each is usually associated with smaller or larger hands. Which means that every mouse is designed to take advantage of these styles. Take the Xornet II by Cooler Master, for example. It's ridiculously tiny—it may as well be designed for Ewoks—but that doesn't stop it being a good mouse for those select few. Corsair, on the other hand, has always managed to impress us with the accommodating nature of its mice. Time after time, it's produced precision pointers that cater to a wider range of hand shapes, sizes, and styles of play than any other. So does the Scimitar follow suit?

At its heart is a Pixart Technologies ADNS-3988 12,000 dpi monster of an optical sensor. On top of that, it features a 1ms response time, 17 buttons, and no fewer than four full 16.8-million-color RGB lighting zones. All of which you can control and tweak in Corsair's well-constructed Utility Engine software.

So how does it feel? Well, if you're a palm grip mouse wielder, it's very comfortable. With the palm of your hand resting gently over the Corsair logo, you have more than enough friction and ergonomic security to ensure you can easily glide this mouse elegantly across your gaming surface. You're certainly not in any danger of hammering those 12 dedicated switches littered over the left-hand side of the mouse. The same can't be said if you're a fan of the fingertip grip, though. As your fingers naturally rest on the sides of the mouse for grip, you may have a habit of placing too much pressure down, and activating any of the 12 cooldowns and abilities you have bound into those mighty mechanical menaces. That said, the amount of pressure required to activate any of those aforementioned abilities is considerable, and it depends on how strong your grip is. Our advice? Check it out in store first if you're concerned.

MANY BUTTONS, MUCH USE

But the real question is, are those buttons worth it? We decided to put the Scimitar through its paces in a variety of online MMOs, and it seems to be a very game-dependent thing. In games such as *World of Warcraft,* it excels at being that go-to emergency button for cooldowns, potions, interrupts, and other useful abilities. Swapping over your entire rotation to it, on the other hand, although possible, takes a fair while to adjust to. Where this mouse does shine, however, is when used in conjunction with games such as *Star Citizen.* Certainly, if you're piloting your ships with a keyboard and mouse, having the ability to manage your shields on the fly, without having to scramble over to the numpad, is a lifesaver. Cycling through countermeasures, deploying flares, and switching between targets all becomes a hell of a lot easier with the added support of those additional buttons.

Overall, the look and feel of this mouse is gorgeous. Although the grip for your pinky and right finger can be a little abrasive, the soft-touch finish covering the rest of the mouse is stunning and very thick. Overall, the LED lighting zones are great for color matching your setup. However, the biggest downside has to be the yellow accent incorporated into the design. Why oh why, Corsair, did you not make it white or black, or available in other colors?

But, alas, we must conclude this review. Corsair's Scimitar is precise, comfortable, and adaptable, depending on your hand style. Although we do have concerns for claw and fingertip lovers, overall the build quality and feel of Corsair's latest MMO and MOBA dominator is phenomenal. Just hurry up and make a fully black one already, Corsair. **–ZAK STOREY**

VERDICT
8

Corsair Scimitar RGB Gaming Mouse

⊞ **BLACKBEARD** 12 adjustable buttons; comfortable for palm users; four LED lighting zones; 12,000 dpi sensor; premium finish.

⊟ **ROBERT MAYNARD** Concerns for fingertip and claw grip; buttons very game-dependent; yellow accents.

$80, www.corsair.com

SPECIFICATIONS

Sensor	Pixart Technologies ADNS-3988 Optical Sensor
Polling Rate	125, 250, 500 and 1,000Hz
Max Sensitivity	12,000 dpi
Programmable Buttons	17
Weight	0.3 lb

Samsung Gear VR

Competent virtual reality on the go

SAMSUNG
Gear VR
Powered by oculus

If you have a compatible Samsung phone, you have to get this.

WE'VE BEEN DREAMING about virtual reality for years, but up until now, those dreams have been pretty well unfulfilled. While we'll have to wait a bit for the release of the crème de la crème of modern VR—Oculus Rift and HTC Vive—you can get a good taste of it now with Samsung's Gear VR.

Made in partnership with Oculus VR, the Gear VR is a headset attachment for modern Samsung phones, with support for the Note 5 and S6 series devices. We tested ours with Samsung's S6 Edge. While the headset is made mostly of plastic, inside are optics that magnify and refocus your eyes on your phone's screen. The phone locks into place via a micro-USB connector, and there's some foam padding around the face plate. The Gear VR also has an IPD adjuster, to accommodate varying pupil distances, and a volume rocker. You secure the headset via a horizontal strap that wraps round the back of your head, and there's an optional strap that goes straight down the top-middle of your head. Once you lock your phone in place, it automatically engages VR mode, and you can navigate menus using the headset's physical back button and four-way directional touchpad on the right. But perhaps the niftiest feature of the Gear VR is that it retails for $100.

What does the Gear VR feel like? Inside the headset, you have access to roughly an 80–90 degree field of view. Within this view, you can look around with the help of the headset's accelerometer and gyroscope. Tracking is pretty much 1:1. When VR experiences are done well, the headset is able to trick your brain into believing that your body is somewhere it is not. Of course, the experience isn't perfect. With the S6 Edge's 1440x2560 screen, the "screen door effect" wasn't bad, but you can still make out some of the pixels if you try. Also, sometimes the headset will be disoriented and the view will go off-axis, but by holding down the back button, you can bring up the menu to reorient the screen to the direction in which you're looking.

We were pleasantly surprised by how many apps there were at launch. There's a wide variety of content, ranging from games to movies and beyond, and a lot of it is free. In terms of games, most of them have you using your head to look at targets in a shooting gallery. This can quickly start to feel shallow and tiring. Because Gear VR is running on Android, it inherits the platform's cheap-quality games. And because it's running off a phone, don't expect *Crysis*-level graphics. There are some fun VR games at the moment, however. *Land's End* makes you feel as though you're a floating wizard in a fantastical land, trying to solve puzzles. In *Omega Agent,* you feel like you're floating through a city using a jetpack. There's also an arcade app that, as the name implies, throws you into a virtual arcade, and enables you to play old-school games.

PRESENCE AND CORRECT

Even if you aren't interested in games, the Gear VR has a bunch of other experiences to sift through. There is a ton of 360-degree photos and videos to view, and you can even watch 2D movies in a 3D environment. There's essentially a movie theater app that enables you to watch any movie you have on your phone in various three-dimensionally fleshed-out environments. Netflix also has a VR app that enables you to watch your favorite content in a virtual cozy cabin. Virtual tourism is another big component of Gear VR, and there's a healthy number of experiences that take you scuba diving with sharks or ringside at a fight. Surprisingly enough, perhaps the most compelling aspect of Gear VR is the social app. Here, you choose an avatar and can sit in a virtual theater, and watch live Twitch streams or online videos with strangers from across the globe. There is a certain sense of "presence" there.

That's not to say that the Gear VR is without flaws, however. The biggest issue here is motion sickness. It's better than the Oculus Rift development kit 2, but if the experience isn't well optimized, chances are you're going to get a little dizzy; your mileage will vary, of course. We suspect that its 60Hz refresh rate has something to do with it, as Oculus has stated in the past that 90Hz and above is what's comfortable for most people. Gear VR does try to mitigate this issue by providing comfort ratings for each app. Other issues: The Gear VR quickly drains the phone's battery, and tends to overheat the device. While you can't do much about the heat, you can charge the device while using it. The screen also tended to fog up when we had it on a little too tight, and we encountered several audio incompatibilities using a Bluetooth headset. To top it off, the Gear VR can be a bit heavy after extended use, even though the headset itself only weighs 0.62 pounds. Add to that the weight of the phone, coupled with experiences that force you to look up constantly, and it can cause fatigue.

Despite these problems, however, if you have a capable Samsung phone, getting the Gear VR is a no-brainer at $100. There's a decent amount of content already, and we're confident it will only continue to increase. The big question is whether people who are currently content with their non-Samsung smartphones should jump aboard. Unless you're a die-hard VR enthusiast, we suggest holding off until gen two. Hopefully, by then, it will have a faster refresh rate, wider FOV, and perhaps some integrated speakers. This additional time will also allow the Oculus store to make some UI improvements and bolster its library. If you have a compatible phone and are at all interested in VR, though, gear up for a good time! **–JIMMY THANG**

VERDICT

8

Samsung Gear VR

+ **GEAR VR** A lot of varied content; social VR adds a sense of presence; resolution is surprisingly good; only $100!

− **FEAR VR** Overheats and drains phone's battery life; some motion sickness present, depending on experience; can get heavy after a while.

$100, www.samsung.com

Corsair Hydro H5 SF

Small form factor water-cooling is now a reality

LET'S CUT TO THE POINT. Piecing together a small form factor build is always going to be a nightmare. If you've had any experience working in those tiny, cramped spaces, you'll know that getting every inch of extra leverage is vital. Couple that with an incredibly limited number of potential cooling options, and you're well on the way to shredded fingers, busted egos, and general frustration when trying to beef up and perfect your small slice of ITX heaven.

Let's give you a hypothetical scenario to add a little clarity to the situation. You're a well-rounded teenager, and you've been saving up for a year now to build your very own ITX chassis ready for university. You don't know exactly how much space you're going to have, and being a true PC gamer, to hell are you using a laptop. You price up a build: Intel Core i5-6600K, 8GB of DDR4, Nvidia GTX 960, all in your favorite case, an In-Win 901 Mini-ITX chassis. After all, what's a better conversation starter than that beautiful piece of aluminum craftsmanship? There's just one problem: It only supports one 92mm fan in the rear, and another 120mm fan in the front. So what's the solution? Stick with a retail cooler, or head for a low-profile option instead, most of which have a habit of throttling your overall CPU performance?

CORSAIR TO THE RESCUE

Well, not anymore. Corsair has just launched its first iteration of the Hydro H5 SF, a small form factor, all-in-one liquid cooler. Based loosely on the design of the Hydro H100i, this CPU chilling marvel features a single 120mm fan, in a setup that quite closely resembles the likes of traditional blower graphics cards. Once installed, the fan faces toward your CPU block, sucking cool air from around your motherboard into an innovatively designed shroud and radiator combo. It then pushes this hot air sideways, straight out of the back of your chassis. What's impressive is that it manages it all while retaining a snug 84mm of clearance.

Mounting the H5 SF is a simple affair—if you've had any experience with AIOs, you'll be used to the backplate and screws mechanism found on most of the closed loop coolers out there. The only noticeable difference is a step back to the original H100i's CPU block, with its magnetic securing bracket situated on top of the CPU block. Once you've mounted the heatsink to your CPU, it's just a case of installing the proprietary support bracket, then securing the radiator portion of this AIO to that. It's advisable to do this second to last, as you'll have little room to maneuver once it's in place, but you'll still have plenty of space to slot in your GPU.

However, the biggest shocker with this bad boy is the performance. We tested the H5 SF against one of our favorites, Noctua's NH-C14S. As far as low-profile coolers go, the C14S is the baddest of the bunch… or so we thought. We ran a set of four benchmarks, under four separate conditions—100 percent fan speed, 60 percent fan speed, stock frequency, and overclocked to 4.6GHz—and in every scenario but one, the Hydro H5 SF came out on top, with an average of two degrees difference between the titans. Admittedly, two degrees doesn't sound like a lot, but when you couple that with the fact that the C14S is 31mm taller, and features a fully configured 140mm fan to boot, those figures speak for themselves.

Ultimately, both of these coolers are impressive feats of engineering. Noctua has long been renowned for its cooling and noise optimizing prowess. Yet for once, the king of the hill has been unseated, with Corsair rightfully taking its place as the ITX chilling champion. The Hydro H5 SF is an incredibly innovative feat of water-cooling design—packing so much thermal regulating potential into such a small form factor is astounding. Couple that with a lack of beige, a sleek black style, and a price tag $5 less than the NH-C14S, and, well, there's nothing left to say. **–ZAK STOREY**

BENCHMARKS

	Corsair Hydro H5 SF *Stock*	Noctua NH-C14S *Stock*	Corsair Hydro H5 SF *Overclocked @ 4.6GHz*	Noctua NH-C14S *Overclocked @ 4.6GHz*
Prime95—100% (°C)	**54**	57	**57**	61
Prime95—60% (°C)	**56**	60	**59**	61
Cinebench R15—100% (°C)	**58**	59	**62**	64
Cinebench R15—60% (°C)	**59**	61	**65**	66
Fire Strike Ultra—100% (°C)	**54**	**54**	**57**	59
Fire Strike Ultra—60% (°C)	55	**54**	**59**	60

Best scores are in bold. All benchmarks were performed on an open-air test bench at both 100 percent and 60 percent fan speeds, using an Intel Core i7-6700K, ASRock Z170 Gaming ITX, 16GB Corsair DDR4, and a GeForce GTX 980.

VERDICT
9
KICK ASS

Corsair Hydro H5 SF

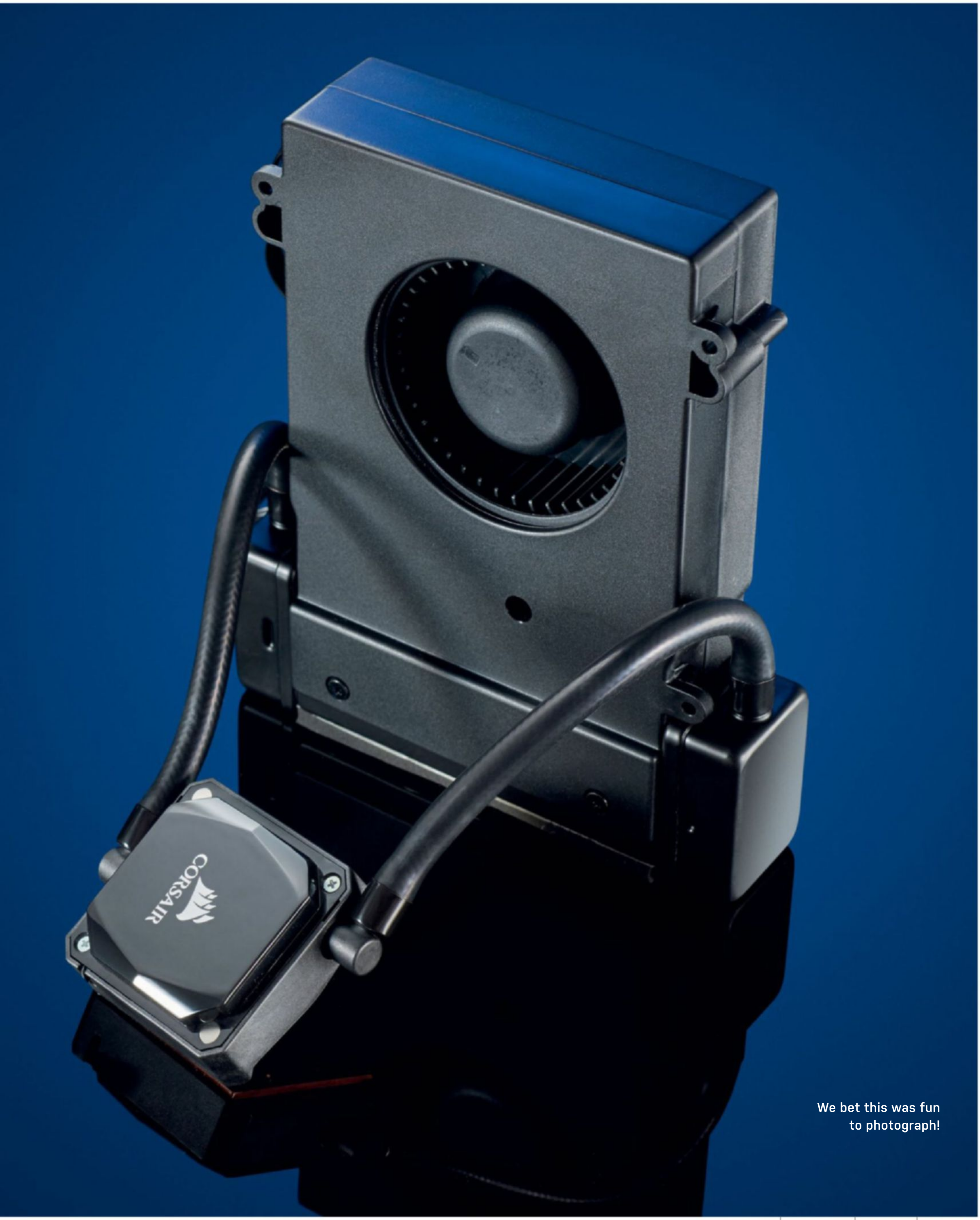
+ **HYDRO** Super small form factor; innovative design; water-cooled; easy mounting mechanism; stunning performance; clean looks; perfect price.

- **PUDDLE** Hides motherboard; older H100i water-block design; ITX only; a bit noisy.

$80, www.corsair.com

SPECIFICATIONS

Socket Support	AMD: AM2, AM3, FM1, FM2 Intel LGA: 115X, 1366
Motherboard Compatibility	ITX only
CPU Clearance	84mm
Radiator Dimensions	6.5x1.6x2.2 inches
Fan Noise Level	36–42 dBA
Warranty	Five years



We bet this was fun
to photograph!

MSI Z170A Tomahawk

Best of the budget boards?

THERE'S AN OLD ADAGE floating around the Internet that goes a little like this: "Performance motherboards don't exist." We'll be the first to admit that over the last few years this has held true. If you take a wander down memory lane, back to the P67 and Z77 chipsets, they seemed to lack anything in regard to differential performance gains for the average Joe. After all, the vast majority of us lack the ability to swap out 25 CPUs in the search to find the perfectly binned high-end CPU.

Fast-forward to 2016, and a fair chunk of this has changed. With M.2 and U.2, premium on-board audio, water cooling options, and a variety of game-changing voltage regulation, thanks to the removal of the FIVR from Skylake's chip design, we're at last graced with a modicum of variance when it comes to mobo performance.

That's all well and good, but if you're looking to build a budget-specced gaming machine, the idea of dropping $300-plus on a motherboard just for a few extra hertz here and there isn't appealing. Enter MSI and its Z170A Tomahawk. This aggressively priced Z170 motherboard provides just enough wallop and features to sate any gamer. Couple that with a snazzy new red, black, and white color scheme, and we're on to a winner.

So what does $150 buy you? Well, you get the usual Z170 features: up to 64GB of DDR4 memory, support for the latest Skylake CPUs, plenty of SATA and USB support, plus the additional PCIe lanes for more advanced storage solutions. Speaking of which, there are two M.2 slots, six SATA 6GB/s ports, a right-angled USB 3.0 header, and fully separated audio componentry to reduce any noise generated by all that power-hungry hardware you're about to throw into your new build.

AN AX TO GRIND?

For the price, you do lose out on a smidgen of memory bandwidth, and on top of that you suffer with a lower overclock potential, too. We maxed our chip out at 4.8GHz. However, if you're not interested in any of that crazy CPU-boosting power, and are just after a good quality gaming motherboard, the Tomahawk will serve you admirably. As you'd expect, there's no performance improvement in-game. We registered a clean sweep of 27fps average in *Shadow of Mordor* at 4K. The same as every other motherboard we've tested with this config.

Sounds like an ideal motherboard then? Well, mostly—for the money, you get a dependable, well-rounded backbone for your system. But, as always, there are negatives. The cutbacks necessary to include such a hefty feature set at such a low price have made an impact on the board's strength; there's way too much flex. If you're running an AIO watercooler, it shouldn't be too much of a problem, but if you're considering an air-cooled tower or a dual-GPU setup, you might want to reconsider. On top of that, there's only access to five on-board fan headers.

Ultimately, the Tomahawk is a great entry-level gaming motherboard. It comes with solid performance, a wide variety of support for newer storage solutions, and performs—for the vast majority of us—just as well as any of the more premium boards out there. The lack of cooling support and thinner PCB are cause for concern, but if you're not throwing excessive amounts of hardware on to this bad boy, you'll be more than happy with this choice. –**ZAK STOREY**

VERDICT

8

MSI Z170A Tomahawk

⊞ **BATTLEAX** Ample storage solutions; solid performance; affordable; good audio for price; great software suite.

⊟ **WOODCUTTER** Thin PCB; lack of cooling options; not strongest overclock.

$150, www.msi.com

BENCHMARKS

	MSI Z170A Tomahawk	MSI Z170A Gaming M7
Cinebench	922	**923**
X264 V5.0.1	**20fps**	**20fps**
Memory Bandwidth	27GB/s	**30GB/s**
Shadow of Mordor 4K	**27fps**	**27fps**
Maximum Overclock Achieved	**4.8GHz**	**4.8GHz**
Cinebench @ OC	**1,064**	1,026
Power Draw Idle	**50W**	84W
Power Draw Peak	346W	**318W**

Best scores are in bold. All benchmarks performed with an Intel Core i7-6700K, 16GB DDR4 2400, GeForce GTX 980, a Samsung 850 Evo 500GB, and a Samsung 850 Pro 2TB.

SPECIFICATIONS

Chipset	Intel Z170
Socket	LGA 1151
Form Factor	ATX
Memory Support	DDR4/3600
Storage	6x SATA, 2x M.2, 1x SATA Express
PCI-Ex16	2

Be Quiet! Silent Base 800

Fantastic noise canceling, but could do with more modularity

EVER SINCE 2008, BE QUIET!'S ethos has been about one thing: silence-optimized computing. Originally a power supply manufacturer, the German company rapidly expanded into cooling solutions, bringing with it the level of precision for which our Germanic cousins are so famed. It also provided one particular product that rival outfit Noctua failed to deliver on until just very recently: black high-performance fans. Which means it wasn't a huge surprise when Be Quiet! announced its first iteration of a sound-dampened PC chassis, the Silent Base 800.

A noise enthusiast's wet dream, the steel chassis houses sound-dampened side panels constructed of a plastic polymer, as is the bottom. Although these are removable, it's advisable to take a quick dive into the instruction manual, because it's not as intuitive as we would expect with modern cases. The interior layout touts some solid modularity—the included 5.25-inch bay cannot be removed, but the two 3.5-inch drive cages located below that can be. You'll lose out on a considerable amount of additional storage space by doing this, but it allows the two included Be Quiet! Pure Wings 140mm fans to really take advantage of that extra room, leveraging some impressive airflow throughout your system. Once you remove the rear panel, you're greeted with ample cable management space, with the back of the motherboard tray also housing two 2.5-inch drives.

As for cooling, well, if water-cooling is your game, the Silent Base has room for a 240mm or 280mm radiator in the roof and the front of the chassis, with plenty of space for push-pull. And if that's not enough, you could always throw another 120mm rad in the rear as well.

TOUGH COMPETITION

There's no doubt at this point, then, that the Silent Base 800 is a competitive chassis. However, in an incredibly loud market, we're just not sure whether this Germanic case can create enough uproar to be heard over many of the other silence-optimized gaming cases available. In particular, we're talking about Fractal Design and its Define R5. We'll admit, it's a favorite of ours, and being one of the most recognizable silence-optimized brands on the market today, the Silent Base has a lot of ground to make up.

Although definitely a contender, the 800 doesn't quite make it. The build quality of the panels, although featuring a soft-touch finish, similar to that introduced by Bitfenix way back when, still harbors a plastic construction and feel, leaving the strength of those panels somewhat wanting. The modular capacity found within the interior can feel a little constricting, and it simply doesn't feel like a fully flexible ATX chassis. All that aside, the addition of rubber mounting on all of the hard drive bays, and the inclusion of the premium Be Quiet! fans, is definitely a plus. What would have been impressive was if Be Quiet! had included an integrated fan hub to help control the vast array of cooling options you have at your disposal.

Ultimately, the Silent Base 800 is deafeningly quiet, and it's certainly a good option for those wanting something with a little more flair than Fractal's Define R5. That said, it simply feels too rigid for our liking. There's not enough customization internally, and the inclusion of such a large 5.25-inch drive bay in this day and age makes little to no sense in a case that's supposed to be optimized around silence.

–ZAK STOREY

VERDICT 7

Be Quiet! Silent Base 800

⊞ **WHISPER QUIET** Great noise dampening; good-looking design; strong SSD-mounting solution; anti-vibration mounts; premium fans.

⊟ **MEGAPHONE** Feels flimsy; not a huge number of cable-routing ties; requires assembly; mostly plastic.

$150, www.bequiet.com

SPECIFICATIONS

Form Factor	ATX
Dimensions	19.5 x 10.5 x 22.0 inches
Cooling	Front: 2x 120/140mm (included); Top: 2x 120/140mm; Rear: 1x 120mm
CPU Cooler Clearance	6.7 inches
Graphics Card Max Length	11.4 inches (with HDD brackets); 15.7 inches (without HDD brackets)
Storage Support	7x 3.5-inch HDD mounts; 2x 2.5-inch SSD mounts

Turtle Beach Ear Force Stealth 450

Stunning audio—but it comes at a cost

AUDIO IS ONE of the most important ingredients for a stunning gaming experience. It's also very easy to ruin. As PC enthusiasts, we are well aware of this. We know that it depends on the quality of the drivers, the sophistication of the components, and the condition of the equalizers running at the heart of your high-frequency, vibrating canisters. So when a company such as Turtle Beach comes up to us, ready to share its latest headset, it would be remiss of us not to say we were concerned. After all, what could a company that specializes in consoles be able to offer? Regardless, we pushed our preconceived prejudices aside, and decided to give it a chance. And, boy, was that a good decision!

The Ear Force Stealth 450 is a set of wireless, 7.1 surround sound gaming headphones. It embraces a set of 50mm neodymium magnetic drivers, with a frequency response ranging from 20Hz all the way up to 20KHz, and includes a detachable omni-directional mic. Not too shabby a feature set for $130.

As far as audio reproduction goes, the Stealth 450 headphones are clean and crisp. Amazingly, Turtle Beach has managed the impossible for a gaming headset: The bass is where you'd expect it—there's a lot of it, in other words—but the clarity of the treble and mids hasn't been lost. This means you get a remarkable listening experience. Seriously—these headphones deliver earfuls of joy.

On top of all that audio goodness, Turtle Beach has thrown in some nifty software features to help you get even more out of your headset. There are four different EQ presets embedded into the headset: bass boost, bass and treble boost, vocal boost, or natural sound. Honestly, though, if you're after a really enjoyable listening experience, just throw the bass and treble boost on, and leave it there. There's also a handy little digital voiceover for whenever you switch on the headset, to inform you about which preset you're in, whether the mic is muted, and also to alert you if the headset is about to turn itself off.

NOT FOR BIG-HEADS

The biggest problem with the Stealth 450 comes down to its fit and form. It's a tiny bit on the small side. And although it fits fine around those with an average cranium, anyone with a larger skull may have problems. Another concern is the size and shape of the ear cups themselves. Instead of the traditional circular style, they're actually oval in design. Again, if you've got small ears, then great—otherwise, you might be forced to endure this as on-ear headphones instead. Fortunately, the headset is quite flexible, and with a bit of force, you can set it to the right size if it is a little tight. The ear cups, though? Well, no, you're stuck with those. Other than that, the padding is comfortable, the fabric could be a little softer, but overall, thanks to the plastic frame, it's incredibly light and comfortable, even during those longer gaming sessions.

Unfortunately, we did encounter some software-related problems. The headset doesn't seem to work particularly well alongside Windows 10's system volume mixer. From 1–99, it's on at 100 percent, and when you're at zero, of course, it's muted. Oddly, this doesn't extend to games or applications. YouTube, Google Chrome, and all of our game suite worked just fine. And, of course, there is an inline scroll wheel on the headset to adjust volume manually as well. Still, very odd.

As far as the mic goes, it's fine—you'll be clear and audible in voice chats. It has a tendency to be a little tinny, but it's more than clear enough. The fact it's removable is a nice touch—great if you want to get it out of your face when you're not raiding Hellfire Citadel with your buddies.

All in all, it's a great headset. The sizing might not be ideal for everyone, but the audio quality is second to none. For this price, you're not going to get much better, and from a company that specializes in consoles, that's high praise. **–ZAK STOREY**

VERDICT 8

Turtle Beach Ear Force Stealth 450

+ TOUR DE FORCE Fantastic audio; easy to install; four equalizer presets; good battery life; lightweight.

− FORCED OUT Abrasive fabric; rather small; plastic construction; mic quality OK.

$130, www.turtlebeach.com

SPECIFICATIONS

Driver Size	50mm
Frequency Response	20Hz–20KHz
Connection Type	Wireless and USB dongle, 4-feet 3.5mm mobile cable
Battery Life	15 hours
Microphone	Detachable omni-directional

Corsair Carbide 600C

Inverted motherboard tray, silence optimized: What's not to love?

39,225,600 SECONDS. That's how long it's taken Corsair to release a new chassis. A case that's no doubt been in development far longer than that. But there's a lot to consider. And when you have a reputation for case-building as great as Corsair does, it's not difficult to understand why it's taken this long. Constructing a chassis is a complex affair—finding exactly the right design style, including the perfect feature set, and matching the ideal price point is always a balancing act.

So this is the 600C, Corsair's latest addition to its Carbide line-up. Generally speaking, these are chassis that have primarily been optimized for silence, making sure the hum of your PC doesn't make its way into your eardrums. Quite a shock, then, to see this windowed edition make an entrance. Interestingly, it still features a lot of the qualities you'd find in the windowless variant. The same sound-dampening material is embedded into the front of the chassis, with just a smidge more lining the 5.25-inch bay covers. On top of that, the feet have a nice 10mm or so of rubber on the base, raising the bulk of your system three inches off the ground.

INVERTED SNOBBERY

But, really, all that's just waffle compared to the most interesting design choice taken with this colossus. And that's the interior layout. This is the first Corsair case in living memory that features an inverted motherboard layout. It's also the first Corsair chassis outside of the Carbide Air series that includes a semi-compartmentalized design. The PSU, SSDs, and hard drives are all hidden away above and behind the motherboard tray, or sneakily disguised, thanks to that snazzy-looking top PSU cover.

It's the inverted layout, though, that's by far the biggest shocker in this new design. There's no doubt that this is going to make for one hell of an argument on the old interweb. We can see it now: sucking in hot air to the GPUs, complaining about the orientation for graphics card logos, and so on. It certainly goes against the norm, especially for reference design cards. In our opinion, however, it's arguably a far more innovative and interesting design style than the standard ATX variants we usually see. It helps to separate the Corsair 600C from an overly stagnant market. It's a bold move but, quite honestly, a necessary one, because the number of inverted windowed cases is very small indeed.

Cooling support is still solid. You do lose out on those two additional 120mm fans in comparison to, say, the Obsidian 750D, but there's still ample cooling potential to help keep your system on ice. If watercooling is your game, well that's another kettle of fish entirely. It is possible to install up to a 360mm rad in the bottom, a 140mm rad in the rear, and a 280mm rad in the front—however, if you're looking to mount your reservoir traditionally to the right (or in this case, left) of the motherboard, you're seriously going to struggle. Your best bet would be to take advantage of that hidden front drive cover, and use a 5.25-inch bay reservoir pump combo instead, but even that might be a bit too risky, and you'd be giving up possibly both of your 3.5-inch drive bays in the process.

Ultimately, this case is a stunning example of what can be done with an inverted layout. The PSU cover is a fantastic addition, and although it's pretty limited for custom loop watercooling, this case is ideal for those looking for a hassle-free and easy build. The only downside we can see beyond that is the lack of storage options. But honestly? How many do you really need? **–ZAK STOREY**

VERDICT **8**

Corsair Carbide 600C

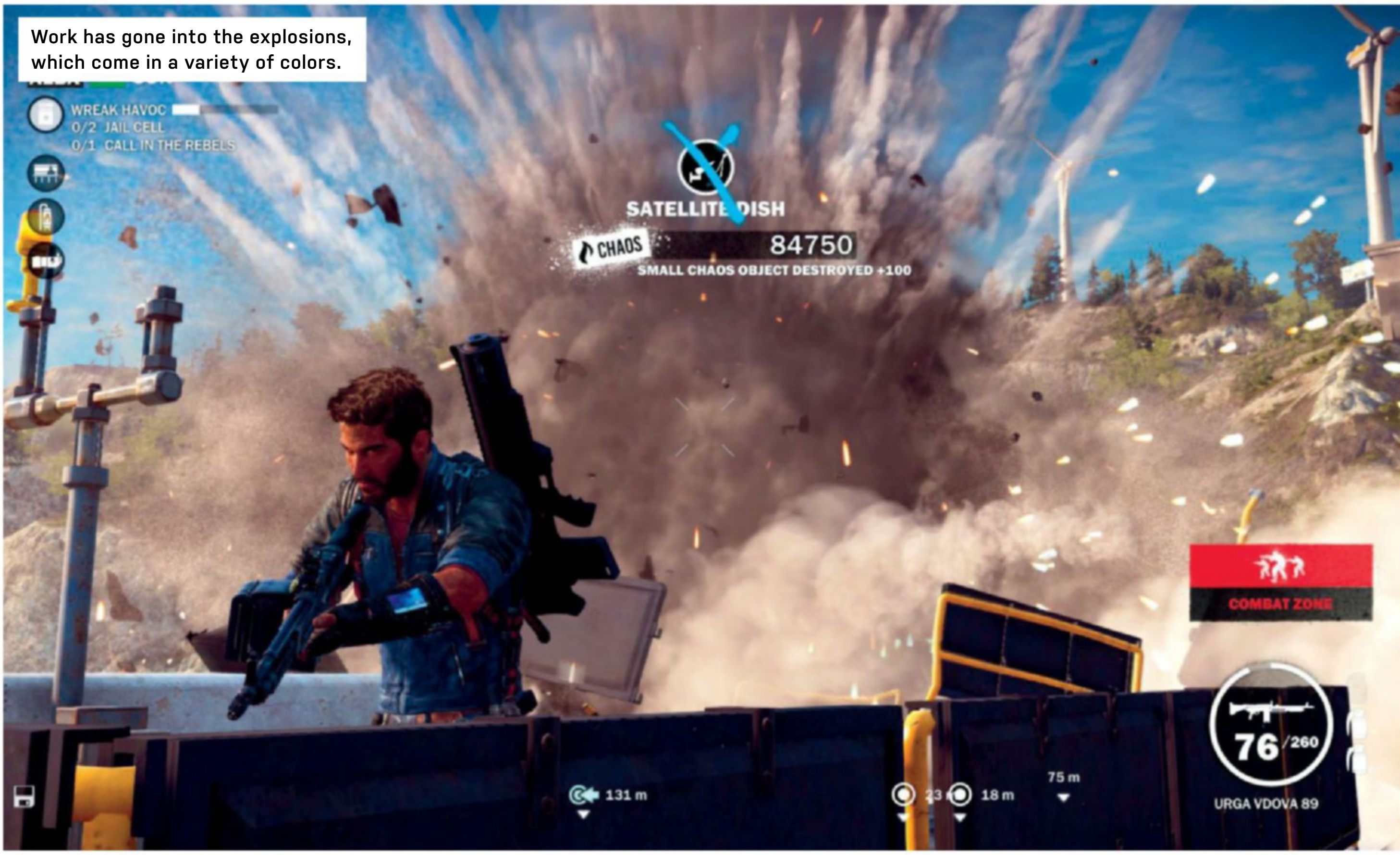
+ INNOVATIVE Fantastic finish; brilliant windowed panel; sound dampening chassis; solid airflow; innovative design.

− COUNTERPRODUCTIVE Inverted layout is acquired taste; limited storage options; watercooling is tight.

$155, www.corsair.com

SPECIFICATIONS

Form Factor	ATX
Dimensions	13.4x16.9x15.9 inches
Cooling	Front: 2x 140mm (included), Bottom: 3x 120mm or 2x 140mm, Rear: 1x 140mm (included), HDD Rack: 2x 120mm
CPU Cooler Clearance	7.9 inches
Graphics Card Max Length	14.6 inches
Storage Support	2x 3.5-inch HDD mounts, 3x 2.5-inch SSD mounts



Work has gone into the explosions, which come in a variety of colors.

Just Cause 3

Mr Boombastic returns to put the "rad" in paradise

FUN IS A FUNNY THING. Videogames should be fun, so to approach them expecting to be entertained is perfectly reasonable. *Just Cause 3* knows this, and the first thing you do is surf a plane while shooting stuff with a rocket launcher.

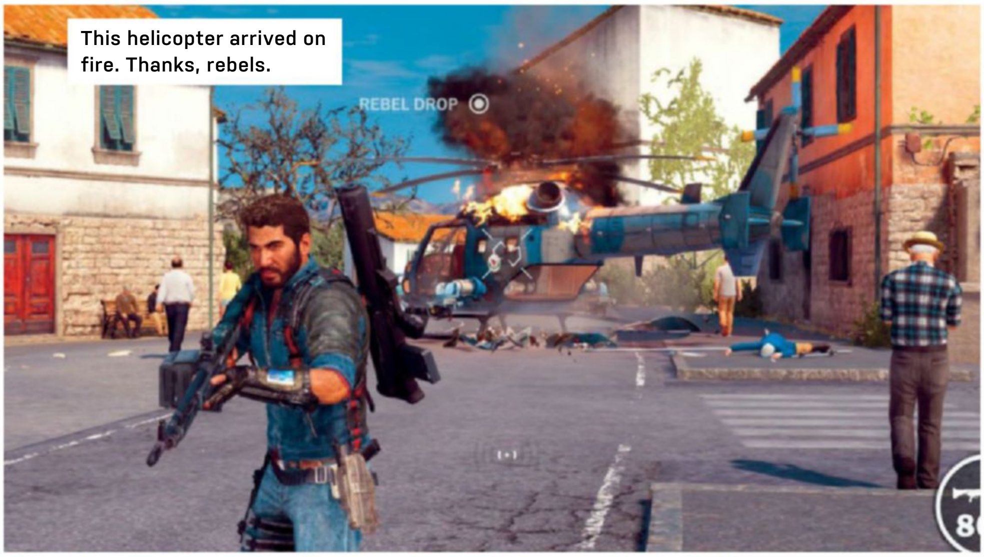
Actually, no. The first thing you do is wait while protagonist Rico sits on a beach doing nothing—presumably it's a loading screen—then wait until the game logs in to Square Enix's servers, then sit through another more explicit loading screen (one minute 23 seconds in total for us; happily, in-game restarts and checkpoints are quicker). Only then, accompanied by a lounge version of the Prodigy's *Firestarter,* do the explosions begin.

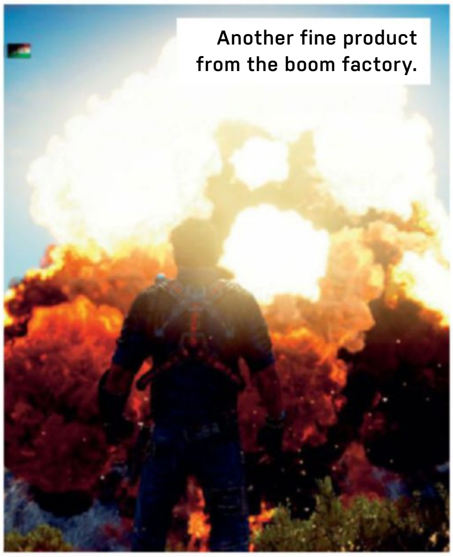
And when it does get going, *Just Cause 3* is a blast. Returning home to the Mediterranean island nation of Medici (a sunny, rural place, with blue skies, beautiful seas, and dry fields, where farmers drive tractors up and down with no agricultural equipment on the back, while growing vast quantities of flowers), Rico Rodriguez finds Sebastiano Di Ravello in charge. Di Ravello is a dictator with a troubling habit of building large, self-aggrandizing structures to rival Donald Trump. Meanwhile, the ragged rebellion started by Rico's friend Mario is failing to liberate one single town. We're told that life would be better under the rebels' regime, although there's no evidence for this, and the idea of returning towns "to the people" sounds a bit commie to us.

If Rico goes into a settlement, blows some stuff up, lets the ramshackle rebels into the police station, and runs a flag up, it falls under rebel control. You can do this to military bases, too, against stiffer opposition and with more interesting structures to climb and destroy. Doing this unlocks weapons and, more importantly, challenges, which earn you "Gears," which you use for weapon and vehicle customization of the nitrous-boosted helicopter and explosive shotgun type. On top of this, there's a mission structure that sees Rico take down Di Ravello, who wants to take over the world with the help of the magnetic, explosive, and apparently forcefield-generating mineral Bavarium, which is conveniently only found in Medici, and not Bavaria, as you'd expect.

Nothing is out of reach and nothing feels forbidden, as our man leaps around the place, his new beard making him look like the hypermasculine presenter of *World's Deadliest Lawnmower Accidents* on a channel a long way down the EPG. But when you get to the top of that radar emplacement (this dictator likes more big dishes than Adam Richman), so thoughtfully built on the bluffs near the coast, what's up there? Not much. We liberated one such island fortress and considered taking the helicopter parked at the top for a joyride on our way to the next town, but it vanished while our backs were turned. We rebel-dropped (the game's resupply mechanic, which sees a shipping container full of goodies fall from the sky at your location) another one in, and it arrived on fire and unusable.

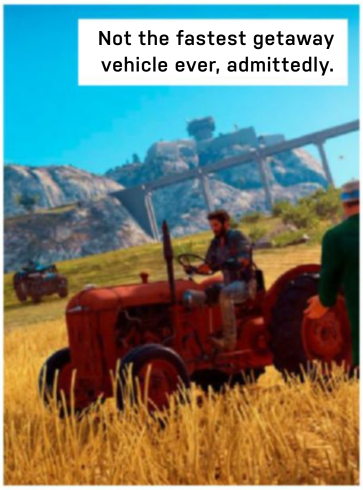
This is a bug, but also typical rebel behavior. They happily unload their guns into innocent walls, ram vehicles together at speed, and run Rico over while he's trying to help them, yet remain in awe of him as

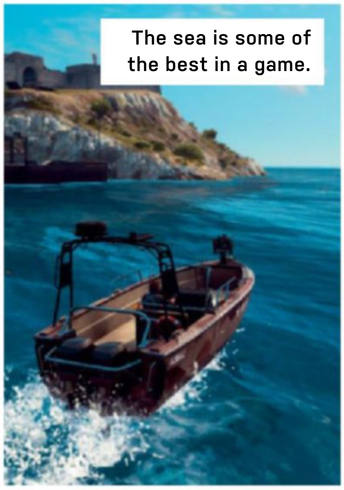

This helicopter arrived on fire. Thanks, rebels.


Another fine product from the boom factory.

Not every vehicle is a glamorous car or a tank.

The wingsuit is the best new addition.


Not the fastest getaway vehicle ever, admittedly.


The sea is some of the best in a game.

their savior. They don't mind when you throw them out of moving vehicles or accidentally gun down their comrades. For that matter, neither do the bad guys, displaying a staggering level of nonchalance as you land a sniper shot from hundreds of yards away, and their buddy's head explodes.

PUPPY LOVE

It's impossible to dislike a game with a physics engine that behaves so much like an eager-to-please puppy, however. Your primary method of getting around the islands is the many vehicles scattered about, from scooters to armored cars to jet fighters. But across shorter distances, the returning grappling hook, infinite parachute generator, and new wingsuit (think *Far Cry 4)* allow significantly faster movement than Rico's sluggish run.

The grappling hook has had an upgrade: A new tethering ability lets you join two objects—an explosive barrel and a fuel tank, say, or a cow and a tree—then yank them together for hilarious results. Who cares if the fuel tank sometimes lunges toward the significantly smaller barrel as though it were welded to the ground? The resulting boom is the same.

Bullets are plentiful and explosives infinite, even if heavy weapon ammo can be scarce. The grappling hook benefits from a degree of auto-aim that guns don't, but its ability to take down an enemy with a rope-assisted flying kick is ruined by the fact that this maneuver often doesn't kill the target. This isn't a game that rewards stealthy tactics—there's no cover system or ability to hide behind low walls—but it does get out of your way, allowing you to approach bases and missions in whatever way you choose.

The towns and bases are all pretty much the same, however, and while doing the challenges (races against the clock, tests of flying accuracy, and the excellent destruction marathons) helps to spice things up, the game ultimately lacks depth.

That's not to say there isn't a lot of fun to be had. *Just Cause 3* is best played in small chunks, and the save and restart system encourages this: Progress autosaves, and hitting "Continue" on starting the game finds Rico lounging against a car somewhere in the last province you entered, rather than where you were standing when you quit. Anything you'd reduced to a smoking ruin remains that way, however.

Just Cause 3 knows that it's fun, that it's chaotic, and that these are its great strengths, but it concentrates on the wrong things. Instead of many islands' worth of cookie cutter towns and a tacked-on story, we need more of the excellent writing and clever mission design that this installment only hints at. –**IAN EVENDEN**

VERDICT
7

Just Cause 3

+ REVOLUTIONARY Gorgeous to look at; lots of boom; great feeling of freedom.

– UNNECESSARY Idiot AI; repetitive; repetitive.

RECOMMENDED SPECS 3.4GHz Intel Core i7-3770 or 4.0GHz AMD FX-8350, 3GB Nvidia GeForce GTX 780 or 4GB AMD R9 290, 8GB RAM.

$60, http://justcause.com, ESRB: M

LAB NOTES

ALAN DEXTER **EXECUTIVE EDITOR**

Memory (Sort of) Matters

...but not as much as manufacturers want you to think

HAVING SPENT THE MONTH surrounded by memory of all shapes and sizes, it's easy to forget how much is "normal" these days. A state compounded by the fact that the two machines I regularly use rock 16GB apiece—thanks to both systems being built around an "enthusiast" processor. Do I actually need so much RAM? Probably not, but at least I know that any problems I encounter aren't due to a lack of it. It isn't Dream Machine levels, of course, and I'm sure there are many readers who scoff at 16GB, but it's more than enough for what I do.

If there's one takeaway from this month's memory roundup, it should be that capacity is important—as long as you actually use it—but there's not much point paying over the odds for the extra speed. Today's processors are awash with memory bandwidth as it is; you don't need even more of something you're not using. And let me reiterate—this is for normal desktop use. I'm sure there are applications that love memory; I just don't happen to use them on a regular basis.

As a certified old fart, I still have SDRAM sticks in my desk drawer that can be usefully measured in megabytes (hey, they might come in useful someday), and my first memory upgrades were of the kilobyte variety. Which means that I'm still amazed by how capacious the latest DIMMs are—16GB sticks are vaguely affordable for those who really need them. Want 128GB in your system? Go for it!

While this is amazing, it's actually flash memory that slackens my jaw the most. At a recent press event, we were handling 128GB microSD cards. That's right—those tiny cards you use in your cellphone and Raspberry Pi 2, which are about the same size as your fingernail. 200GB cards are already available, and 256GB devices are on the way. We really do live in amazing times.

SanDisk
Ultra
200GB
micro SD XC I
10

Memory continues to shrink at an amazing rate, particularly when it comes to flash.

JIMMY THANG,

Online Managing Editor

While the Surface was awkward out of the gate, over time Microsoft has made it a very respectable device. With tablet sales slumping, Google and Apple are trying to jump on the convertible bandwagon with their Pixel C and iPad Pro tablets, but it's a poor attempt to save a dying market. Both devices lack a trackpad, and the iPad Pro doesn't even have a USB port. But the biggest sin that both devices commit is being tied to mobile apps. Conversely, the Surface allows you to use professional video and photo-editing suites. I'm amazed that Apple and Google are audacious enough to just tack on a keyboard and call it a day. Both companies will have to take their learning lumps, just like Microsoft.

ALEX CAMPBELL,

Associate Editor

In January's Build It feature, I paired an AMD FX-9370 with an ASRock 990FX Killer motherboard, which worked fine in our tests. But just because it works, doesn't mean it should. I later discovered that the 9370 isn't approved for the mobo, but only after a BIOS update blacklisted the CPU. The board only supports CPU TDPs up to 140W. The 9370 is a 220W CPU. So, what can you do? You can stick with the stock BIOS, keep the 9370 cool (read: water), and hope for the best. The other (more sane) option is to simply use the 125W FX-8350 instead. The 8350 is 400MHz slower than the 9370 but that deficit can be made up with even an air-cooled overclock.

Editors' Picks: Smart Software

Jarred Walton, senior editor, and Zak Storey, staff writer, discuss their latest finds

KODI

Putting together the ultimate HTPC for your entertainment needs is only step one; step two is finding the right software for it. One of the most flexible and potent pieces of HTPC software around is Kodi, formerly known as XMBC. What's in a name? Plenty, and the reason for the renaming is pretty simple, because the XBMC (originally Xbox Media Center) has long since moved beyond the confines of the Xbox ecosystem. The software is now available for Windows, Linux, OS X, Android, and other platforms.

Kodi is a great piece of software that has a host of features, including support for most video, audio, and picture formats. It can be used to watch and record live TV (with the appropriate tuner hardware), and it's highly customizable. That's perhaps the most potent aspect of Kodi: the add-ons.

Anything you might want to do with your HTPC software is likely useful to others as well, so there are tons of official add-ons already available. If you need more, add SuperRepo (http://srp.nu) as a source, and you quickly gain access to even more options. TV, radio, weather, games, and more are all available at the touch of a button, and the 10-foot UI is great for browsing from your sofa. Best of all, it's free and open source.

KODI
12:03 PM
VIDEOS
MUSIC
PROGRAMS

F.LUX

I'll admit, I'm one of the youngbloods at *Maximum PC.* Many a joke goes around the office when someone makes a reference to an event that happened before the 1990s. But that's put me in a unique position. I barely remember life before the Internet. From the age of six, I was hooked—online and gaming on PCs. Late into the night, I'd play on those old CRT monitors, throwing hours of my life into *WoW* and the *Total War* franchise, and every night I'd struggle to sleep, thanks to that blue light etched into my skull.

It's only since I've gotten older that I've become aware of how much of a nuisance this is. Working late into the night, and being permanently parked in front of a screen, isn't good for your eyes. However, a neat little program called f.lux attempts to resolve these problems. Essentially, it pays attention to what time of day it is. When the sun starts setting, it begins to calibrate your monitor accordingly, reducing the level of blue light, and giving your monitor a nice, warm glow. It does this smoothly over the course of a few hours. Admittedly, it's not ideal for designers who rely on color accuracy, but for those of us—tech journos in particular—who often work late into the night, it's a lifesaver.

f.lux
Download f.lux

GEEK TESTED & APPROVED

Eco USBCell

THE THING ABOUT AA and AAA batteries is that they're so damned ubiquitous. Sure, they're nasty and poisonous when they leak acid. Sure, they're terrible for the environment when you dump them in the trash. But they make the TV remote work, so we have to deal with them.

Even when you have rechargeable AA and AAA batteries, what do you have to use to give them some juice? A proprietary charger, that's what.

The Eco USBCell is a pretty basic idea: a USB AA and AAA battery. Not a USB charger—a USB battery. No kidding. Practically every other small electronic device or battery can be charged via USB these days, so why not these batteries?

The batteries are about as basic as you can get: A USB connector is attached to the body of an AA battery. For the AAA form, there's a strange-looking half-connector. The positive cap of the battery slides over the USB connector to stay in place. The cap has an embedded magnet to attach to the butt-end of the battery, so you don't lose it while charging. The battery requires a 5V USB port to charge, and takes about two hours from empty.

The main downside to the Eco USBCell is the power capacity. At 1,040mAh (450mAh for AAA), it's less than half the capacity of an old trusty Duracell Coppertop's 2,850mAh (1,150mAh for AAA). On the upside, the Eco USBCell is rated for 500 charge and discharge cycles. That means that each Eco USBCell AA battery is equivalent to 182 Coppertops. Not bad for a battery that costs $20 for a pack of four (as opposed to $783 for 182 packs of four Coppertops).

And, of course, it's way better than having a drawer full of questionable or dead batteries. **–AC**

$20 (4x AA or AAA),
www.ecousbcell.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> SATA SSDs
> NVMe Upgrades
> WinSub?

SSD Booting

I want to upgrade my boot drive to an SSD drive. In the past, I have just installed an HDD and loaded an OS on it. Can I do the same with an SSD or are there some other steps that need to be done before loading the OS on to one? Also, while shopping for cables, I have seen SATA2 and SATA3 cables. Is there really a difference or is this just a gimmick? **—David**

SENIOR EDITOR JARRED WALTON RESPONDS: Hi, David. Anyone advertising SATA2 versus SATA3 cables is mostly going after marketing. Technically, neither exists, as the real terms are SATA 3Gb/s and SATA 6Gb/s, and as for performance and throughput, I'm aware of no difference between SATA cables. The only thing you might see is some cables have a retention clip while others don't. If you want to see benchmarks of different cables, Puget Systems checked this out a couple of years ago (spoiler: and found no differences) http://bit.ly/MPC_PSsatatest.

To your question about installing the OS on an SSD, if you're doing a clean install to a SATA SSD, there shouldn't be any change from the usual procedure. If you're trying to clone an existing HDD installation over to an SSD, you'll want to ensure TRIM support is enabled. Check this in a command prompt using the fsutil.exe utility: "fsutil behavior query DisableDeleteNotify"—the result should be "0" if TRIM is enabled. If TRIM is disabled, you can enable it using the same utility: "fsutil behavior set DisableDeleteNotify 0" (and then reboot). This is more of a concern on Windows 7 than Windows 8.1/10 in my experience, though it's been a while since I cloned an HDD to an SSD.

[NOW ONLINE]

WHAT GOES ON BEHIND THE LOADING SCREEN

Yes, we all know that loading screens are super annoying, but there's a lot going on behind the scenes. Check out our online story, in which we delve into the technical side of what your CPU and storage are doing before and between your frag sessions.

We test a wide variety of games and applications, and provide charts and graphs with our analysis. Next time you're twiddling your thumbs waiting for a game to load, you'll have a better idea of what's going on. http://bit.ly/MPC_loading

GTA V's loading screens hide the CPU's hard work.

There's a third topic to mention, and that's the faster non-SATA SSDs that are now arriving. The best ones use NVMe (Non-Volatile Memory Express) with a PCIe Gen3 x4 interface, usually via M.2, though a PCIe expansion card is an option. For any NVMe drive to work as an OS drive, your motherboard/laptop BIOS needs to support NVMe, otherwise the drive will only function as a data drive. You'll also want to install NVMe drivers from the SSD manufacturer to get full performance, at least under Windows. Non-NVMe PCIe drives also exist, and typically don't require special drivers, but you still need an appropriate M.2 slot. If you're after bang for buck, SATA SSDs are the way to go, but for pure performance, NVMe drives are the fastest SSDs around.

NVMe Upgrade

On Black Friday I ordered parts for a PC upgrade that I've been planning for a while. A few minutes before checkout, I made an impulse

↘ submit your questions to: comments@maximumpc.com decision to change from the 850 Evo to the 950 Pro as my boot drive. I did a little more reading after placing the order and it seems the drive might not be recognized by the motherboard right out of the box. The CPU and motherboard I ordered are the i7-5820K and Asus X99-Pro/USB3.1.

Can you offer any insight on what I need to do to get the 950 Pro running as a boot drive?

As for the OS, I have a retail version of Windows 7 Ultimate that I plan to install and then upgrade to Windows 10 before doing a clean install of Windows 10 from an ISO (I've heard that it's possible to install Windows 10 from the start and use a Windows 7 key, but I haven't looked around enough to confirm that yet). **—Chris**

SENIOR EDITOR JARRED WALTON RESPONDS: Hi, Chris. I haven't used that motherboard, but depending on the BIOS revision, that's the main thing you'd need to update in order to boot from an NVMe drive. Thankfully, updating the BIOS is pretty painless and you don't need to have an OS installed—just use the built-in flash utility from inside the BIOS with a USB stick, and you're golden. I tried to confirm that the X99-Pro/USB3.1 supports NVMe, but the product pages make no mention of this feature. However, another page (http://bit.ly/MPC_Amobonvme) says all X99 and Z97 Asus boards support NVMe, so you should be fine. You might not even need a BIOS update, but as you're building a new rig, I'd do it anyway.

As for Windows 10, I've heard there's a way to do a clean install, but I haven't tried it. And truth be told, other than taking a bit longer, I'm not sure a clean install would differ much from a version that came from updating Windows 7/8.1. All of my Win 10 PCs were upgraded, and other than one that was a bit stubborn, it's been pretty painless. Good luck with your upgrade!

Subscription Model?

How long do you think it will be before Microsoft starts a yearly subscription fee for its operating system?

In the early days of PCs, I was a technical writer at an electronics firm. I longed for terminals that had disk drives and enough "smarts" to run independently of a host. Now, 30 years later, I wonder if a personal general-purpose computer will survive. Our current computers seem to be very dependent on the Internet. To support the software to run the machines, I suspect that operating systems will be provided on an annual fee basis, as so much other software is offered via subscription. **—Tom**

SENIOR EDITOR JARRED WALTON RESPONDS: We've been taught for years that every new version of Windows will cost $50 per PC to upgrade, and now Microsoft has tried something different with Windows 10, giving away the upgrade "free" for the first year. How this plays out depends on the results of this giveaway. If Microsoft generates more revenue through other means, thanks to features such as Cortana, Windows Store, Bing, and so on being integrated into Win 10, we may see it become truly free (as long as you enable certain features) permanently.

I'm hopeful that OS fees will disappear entirely. Look at Android, iOS, and OS X—not to mention the various FOSS options, such as Linux—and there's a lot going for such a distribution model. The idea is that there's a financial incentive for the OS maker to give the OS away, and in the case of Android and iOS, that incentive is the app stores. Some suspected Microsoft of making a similar play with the Windows Store, which is part of the impetus behind Valve's SteamOS, but Microsoft backed off the idea of requiring all applications to come via the Windows Store—for now. The dark side of this is privacy concerns, but even with all the data mining going on, I'm not sure any of us would give up our smartphones.

The cynical part of me looks at all the subscription services—antivirus software, Office 365, Netflix, Internet, cable, and so on—and can't help but imagine MS is looking at a huge cash cow. We all know people who pirate Windows and Office software. I was talking with a tech friend who commented, "I did something for the first time in my life today: I bought a legitimate copy of Microsoft Office." The reason was that Microsoft's subscription model and lowered price point made it appealing. For $100 per year, he can install Office 365 on up to five machines—a far cry from the old $360 per copy model used on Office Professional. We might even see a middle ground from Redmond, where the Office subscription also gives you a subscription to Windows. That would be an offer that many like my friend would find very generous.

Facebook Polls

Would you buy a Steam Machine or build a SteamOS rig?

Michael Gieron: It's dealing with an identity crisis; it's a PC game platform, with a console UI, and (depending on your entry price point) console to mid-level PC graphics. The Steam Machine industry, with some time to mature, might be the new "third option" for choosing a gaming platform, or it could distance itself from consumers who are still trying to categorize it as a PC or console. In my opinion, it doesn't belong.

Humza Hayat: It doesn't support most games in the Steam library. Why would anyone switch OS to play games without any compelling reason?

Jonathan Lemonde: AAA games (and/or games I play) run on Windows only. Deal breaker. But I have no doubt that barrier is about to be lifted.

Boe Smith: Nope.

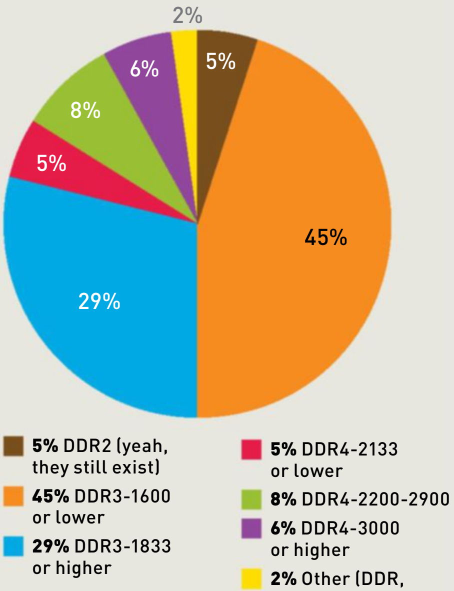
Alex Hansen: Why figure out a Linux distro when Windows 7 or 10 can get the job done?

Matt Janosko: I do not think that I would spend more on a console than the combined total of every single game available for said console. That's just me, though.

Dale Horn: Can I build it using an old computer?

Charles Grooms: You can just download SteamOS; don't fall for these Steam Machines, they're total garbage.

What type of memory do you have in your rig?



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THE BUILDS

BUDGET GAMER

INGREDIENTS

PART			PRICE
Case	Cooler Master Elite 110		$40
PSU	Corsair CS450M 450W/80 Plus Gold		$70
Mobo	ASRock H170M-ITX/ac	NEW	$100
CPU	Intel Core i5-6500		$205
GPU	EVGA 1962-KR GeForce GTX 960 SC		$215
RAM	8GB (2x 4GB) G.Skill Ripjaws V Series DDR4 2133	NEW	$45
SSD	250GB Samsung 850 EVO	NEW	$88
OS	Ubuntu Desktop Linux 14.04 LTS 64-bit		$16

Approximate Price: $779

THIS MONTH SAW PRICES BOUNCE back up again, so we had to make a few compromises. We had to drop the higher-end Asus mobo for its cheaper ASRock cousin, though the trade-off isn't huge. The i5-6500 is a locked CPU, so overclocking features aren't an issue. There are reports of BIOS problems but, from what we see, a BIOS update (available online) is all you need. It features plenty of USB 3.0 ports and 802.11ac Wi-Fi, which rounds out some of the features we want in a mini-ITX build. At $175, it was hard to justify a 500GB SSD, so dropping to an $88 250GB model seemed a wise move. Samsung is still king of SSD performance and capacity for the dollar, so we stuck with our favorite, the 850 Evo. The only other change was switching from the Kingston DIMMs to G.Skill sticks. While the HyperX Fury sticks have better timings than the G.Skill sticks we went with, the price difference of $10 justified the move.

MIDRANGE

INGREDIENTS

PART			PRICE
Case	Phanteks Enthoo Pro M	NEW	$90
PSU	EVGA SuperNOVA G2 650W		$100
Mobo	Gigabyte Z170X-Gaming 3		$130
CPU	Intel Core i5-6600K		$270
Cooler	Corsair H80i		$88
GPU	Asus R9 390 Strix 8GB		$340
RAM	16GB (4x 4GB) G.Skill Ripjaws 4 Series DDR4 2133		$90
SSD	500GB Samsung 850 EVO M.2		$171
HDD	Western Digital Black Series 2TB 7200RPM	NEW	$120
OS	Windows 10 (Download)		$110

Approximate Price: $1,509

WE DON'T LIKE TO HAVE TO COMPROMISE on graphics or CPU when we've got a good base system set up. As we like the Asus R9 390 Strix, we decided to take the price hits and work around them in other places. We saved a little money by going with a new case, the Phanteks Enthoo Pro M. The Enthoo has a lot of modularity and room for video cards. The R9 390 Strix is a big card, and the Enthoo's lack of a bolted-down HDD cage makes installing it a breeze. We used the extra money left over to double our HDD storage from 1TB to 2TB. We still think that the days of needing multiple terabytes of storage on a local machine for media is pretty much over, but some people just don't have a NAS. We were tempted to upgrade the mobo from Gigabyte's Gaming 3 to the Gaming 5, but after checking the specs, we decided to stick with the Gaming 3 model. The Gaming 5 specs are almost identical to its little brother, the Gaming 3, it just sports an extra Ethernet connection.

TURBO

WHEN PRICE INCREASES HIT, they can really add up when we're talking about the turbo build. It pains us to do it, but we had to let go of some storage sexiness to keep our budget in check. The trusty Asus X99-A/3.1 mobo cost an extra $35, while the Corsair Graphite shot up about $18. That may not seem like much in a $3,000 target budget, but this build cost $2,993 last month. That doesn't leave us a whole lot of room for error. To make room, we made some changes.

First, we dropped the big ol' Kraken for Corsair's smaller H80i. We've found that the H80i gets comparable cooling performance as bigger all-in-one coolers, but for a smaller price and package. We actually built our 2015 Fall Turbo build on a 5820K and an H80i, and it worked quite well. Next, we dropped the lovely 1TB 850 Evo and got a 500GB SATA M.2 version instead. We'd like to think that someone spending $3,000 would either build or buy a NAS, but some folks just need that local hard drive. That's OK, too. Just in case the reduction in storage gave anyone the willies, we tacked on a 1TB WD Black.

One thing we spent just a little extra on was our RAM. Sixteen gigabytes of G.Skill's 3,000MHz sticks cost just $5 more than 16GB of the Corsair DIMMs, so we spent the extra $10 for a little more speed. At least we got to keep our dual GTX 980 Tis.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART			PRICE
Case	Corsair Graphite 780T		$178
PSU	EVGA SuperNOVA G2 1,000W		$180
Mobo	Asus X99-A/USB 3.1		$270
CPU	Intel Core i7-5820K		$390
Cooler	Corsair H80i	**NEW**	$88
GPU	2x Zotac GTX 980Ti		$1,300
RAM	32GB (2 kits of 4x 4GB) G.Skill Ripjaws 4 Series DDR4 3000	**NEW**	$210
SSD	500GB Samsung 850 EVO M.2 (SATA)	**NEW**	$178
HDD	Western Digital Black Series 1TB 7200RPM	**NEW**	$75
OS	Windows 10		$110

Approximate Price: $2,979

UPGRADE OF THE MONTH

CYBERPOWER CP1500PFCLCD

Let's face it: Everyone should use an uninterruptable power supply, but few of us actually do. Using a UPS to clean up (and provide backup) power for your PC protects components from spikes, brownouts, sine wave noise, and outages.

The CP1500PFCLCD can clean up power for up to 900W of load, and provide two minutes of power at full load (11 minutes at half load) to save your butt when the lights go out. Even if you go with another brand or model, it's better than trusting your PC's health to your local electric utility company.

$260, **http://cyberpowersystems.com**

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